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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

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Pearlitic Cast Iron: Criticisms Examined.

We thank Messrs. Young, Gresty, Adamson and Mills for their contributions to the discussion on Pearlitic Cast Iron. All of these gentlemen have been careful to point out that there has been no proof submitted to show that pearlitic cast iron is better than those currently manufactured in Great Britain and that the superior comparative tests may be due to the other variables exhibited. Not one of our correspondents has really answered the main point at issue, which is: Would a cast iron containing 0.89 per cent. of combined carbon, all existing as pearlite, exhibit superior mechanical properties when compared with a similar cast iron, having a similar graphite distribution and similar quantities of silicon and phosphorus, and in each case the sulphur correctly balanced by the manganese and made under similar manufacturing conditions? The comparison should indicate which, if any, of the mechanical properties are superior. The answering of this rather involved yet pertinent question might reveal that the fixing of the combined carbon at roughly 0.89 per cent., all existing as pearlite, does control the sulphur in form which makes it a really useful entity. Further, it is possible to conceive that such conditions could likewise control the size of the graphite and render into the fine variety so much to be desired for certain objects. There are some grounds for assuming that the control of one element in cast iron influences and controls another, as is exemplified by control of the condition of the carbon in cast iron by the silicon.

Mr. Gresty attacked the proposal we made for classifying cast iron on its microscopical structure, using the pearlitic-graphitic structure as a base line, but if with this particular structure we are in a position to control the size and distribution of the graphite, associated with presumed fact that balanced sulphur is beneficial, then we start off with a known base. If this base is associated with the peak point of a composite curve of all the mechanical properties of normal cast iron, or of most of the individual curves, then it obviously forms a basis for the establishment of a classification merely requiring designations for those irons forming the two slopes.

We realise that our critics will raise the objection that the production of a structure consisting wholly of pearlite and graphite is not of prime importance, but we would ask them to consider carefully that if it bestows a special influence on the graphite and the sulphur, then with three entities controlled a good if not ideal base is established for the fixing of one element (not chemical element) in the classification of cast iron.

Mr. Adamson's views on the patent aspect of the question are definitely in accordance with our own, and there is nothing to prevent foundrymen from making and selling pearlitic cast iron, providing that the means of its accomplishment do not infringe the German specification, unless, of course, it can be shown that the German method, which apparently involves the pre-heating of moulds, is not novel and prior to the date of the application it had been exploited elsewhere.

Mr. Adamson hazards that Professor Bauer's pearlitic cast iron has been synthetically produced, which may or may not account for the properties exhibited. That to our mind is beside the question. It is very important, but the inference which one is expected to take from Bauer's research is that special properties are to be associated with an all-pearlitic-graphitic structure, and only Mr. Young queried this by an examination of the comparative tests put forward, but even he has not stated with any degree of definiteness that no special properties are to be associated with this structure.

We know that two northern metallurgists possess samples showing this pearlitic structure, and the foundry trade would be indebted to them if they would carry out and publish a series of tests on them, especially some form of shock test. The research would be more interesting if side by side they made tests with a bar containing 1.25 combined carbon and one with, say, 0.25 combined carbon, the other constituents being approximately the same in all cases.

XUM

Metallurgical Research Work at the National Laboratory.

Ferrous Alloys.

The completion of the Eleventh Report of the Alloys Research Committee, referred to in the Report of this Department for last year, appeared to offer an opportunity for reconsidering future policy in regard to alloys research. While it was necessary to carry further the investigation of certain outstanding matters arising from the eleventh report in regard to aluminium alloys, the further advancement of metallurgy presented problems of more pressing importance. The work carried out under the auspices of the Alloys Research Committee, having served to a large extent to lay a sound theoretical foundation for existing knowledge of aluminium and its alloys, the question arose whether similar fundamental work in regard to the alloys of other materials should not be regarded as more urgent than further development of that particular system of alloys. From this point of view there can be no doubt that primary importance attaches to the alloys of iron.

Numerous preliminary experiments have been necessary in order to develop experimental methods suitable for the investigation of the constitution of alloys with extremely high melting points. Iron itself melts at approximately 1,530 deg. C., and some of its alloys, *e.g.*, with chromium, have still higher melting points, and special methods have had to be devised:—(1) To melt the alloys, without contamination from the containing crucible or the furnace atmosphere; (2) to measure the high temperatures with accuracy; (3) to protect the thermo-couple from injury, either by the molten alloys or by gases in the furnace. The alloys have been prepared in a carbon-ring electric furnace, in which the resistor consists of a tube built up of graphite rings. In such a furnace, at a high temperature, the atmosphere contains carbon, and it was necessary to make refractory muffles that are not porous to gas at a temperature of 1,600 to 1,700 deg. C. All the common vitreous or glazed refractories, such as porcelain or quartz, are not sufficiently refractory to withstand these high temperatures without melting or softening, and new refractories have had to be devised to meet the special needs of the case. The best solution of this problem that has so far been obtained consists in the use of a muffle, inside the carbon-ring furnace, made from a mixture of 90 per cent. china clay and 10 per cent. alumina (these proportions may vary slightly), which is a highly refractory article; this muffle is glazed on the outside with a highly refractory glaze, consisting of alumina, silica and felspar.

Pure Iron.

In the first instance, the iron used in connection with these researches was that known as Armco iron, obtained from the Shelton Coal and Iron Company, Limited. This is a particularly pure form of iron, containing about 99.87 per cent. iron, but it has been found that the small amount of impurity was sufficient appreciably to affect the properties and behaviour of the alloys. This iron contains 0.02 per cent. of carbon, but it was considered desirable to eliminate, if possible, even this small quantity. An apparatus has therefore been set up to prepare pure iron by an electrolytic process. A re-determination of the melting point of pure iron has been begun, both in an atmosphere of pure nitrogen and in argon, partly to ascertain more accurately the true melting point of iron and partly to determine the effect of possible combination between iron and nitrogen at the melting point of the metal.

Iron-Chronium Alloys.

The study of the system iron-chromium has been begun, and a considerable number of thermal curves has now been taken over the range of composition extending from 0 to 50 per cent. chromium. The results obtained indicate that the existing iron-chromium equilibrium diagrams are both incomplete and inaccurate. The effect of chromium is to lower the melting point, δ transformation temperature, and A_3 point, while A_4 appears to be unaffected (this is subject to confirmation). These results do not agree with the commonly accepted views, based on a study of iron-chromium alloys not entirely free from carbon (chromium steels), and it is probable that very small quantities of carbon profoundly affect the properties of these alloys. Evidence already obtained shows that alloys made from Armco iron containing 0.02 per cent. carbon, differ markedly from alloys made from high-purity electrolytic iron.

Iron Oxygen.

The effect of oxygen on iron is also being studied. The experimental difficulties of this research are extremely great, and have, as yet, not been satisfactorily overcome. It has been established that oxide of iron is soluble to a very appreciable extent in molten iron, and this solubility is accompanied by a lowering of the freezing point. The solubility in the solid state is considerably less, but that some oxide can be dissolved by solid iron is indicated by a slight lowering of the transformation temperature. The results obtained are of considerable interest in connection with the welding of iron and mild steel. In alloys made from Armco iron, the oxide constituent was frequently found to be duplex, and it is thought that this is due to the presence of a slight amount of sulphur in the iron. When electrolytic iron is used, the duplex structure is not found. No great difficulty is anticipated in completing the investigation of those alloys containing small quantities of oxygen—that is, those in which the oxygen content is insufficient to produce two liquid phases above the liquidus—but further progress appears to depend on the discovery of refractory materials that will resist the action of molten oxide of iron. The chemical analysis of iron-oxygen alloys is difficult, and a completely satisfactory method has not yet been discovered.

Standardised Steel Samples.

Very little progress has been possible during the period under review with regard to standardised steel samples, owing to the fact that the depression of the steel industry has made it impossible to obtain a further supply of ingots suitable for standardised sample production. Some work has, however, been carried out on a sample of cast iron obtained for purposes of standard samples through the courtesy of Dr. L. Aitchison, of Birmingham. Very satisfactory results as regards uniformity have been obtained from a number of analyses of samples of this iron, and corresponding samples for check analyses have been submitted to Dr. Aitchison. The results of these check analyses are not yet available. The sale of the standardised steel samples issued jointly with the Iron and Steel Institute has proved very disappointing during the period under review. Undoubtedly this is due to the very depressed condition of the steel industry, and it is hoped that, with the revival of that industry, a much larger sale of these samples will arise.

Paris and the Italian Conference.

Members of the Iron and Steel Institute who are also members of the Institute of British Foundrymen or American Foundrymen's Association, who intend participating in the Italian meeting of the first-named society, can best do so by cutting out the last day of the Paris programme (Saturday, September 15). This will allow them to join the Iron and Steel Institute party at Calais by leaving Paris at 12 noon, arriving in Calais at 3.35 in good time to catch the special Italian Express at 6.06 p.m., or they can leave Paris at 11.45 a.m. on the Saturday and join the party at Basle. This will necessitate sleeping in Basle, as the special train leaves there at 8.35 a.m. on the Sunday morning. A third method is for members to travel independently to Milan on Sunday, September 16, joining up with the main party on the morning of Monday, September 17. A rebate can be given in any of these cases.

I.B.F. REPRESENTATIVE ON THE B.C.I.R.A.—We regret that owing to a reporting error, it was stated that Mr. E. H. Broughall had been elected to represent the Institute of British Foundrymen on the Council of the British Cast Iron Research Association. In reality, Mr. H. L. Reason, past-president, was re-elected.

New Regulations Proposed for the Cleaning of Castings.

The Home Office has recently published a long report entitled "The Grinding of Metals and the Cleaning of Castings, with Special Reference to the Effects of Dust Inhalation upon the Workers."* It has been prepared by E. L. Macklin, O.B.E., H.M. Engineering Inspector of Factories, and E. L. Middleton, M.D., H.M. Medical Inspector of Factories.

The report contains a fund of information on the nature of abrasive wheels and grinding machinery in general. Much space is devoted to edge-tool work and the like, but even amongst this there is much of interest to foundrymen and metallurgists. The sections dealing with the cleaning of castings is abstracted below:—

Cleaning of Castings.

Castings, after they have cooled, are withdrawn from the moulds, and then undergo more or less cleaning in order to facilitate the subsequent machining operations. This cleaning—known as "fettling" or "dressing"—includes freeing the castings from adherent sand, knocking out cores and lifters, removing risers and ingates, grinding down of excrescences and projections, and general smoothing of the whole surfaces of the castings. Large castings are frequently given some preliminary cleaning on the actual casting floor of the foundry, but generally the castings are removed to a special shop (or part of the foundry) known as a fettling or dressing shop, where most of the operations are performed on rough benches or on the floor.

Machinery has to some extent superseded the hand work, but there is still much done with old files and chisels. For knocking the sand from hollow parts, portable tools, operated by compressed air or belt-driven machines, are sometimes employed, but external adherent sand is removed by hand labour, using stiff wire brushes. Dislodging the sand is often a difficult matter when it has become consolidated in fillets, pockets or long pipes. Ingates and risers are cut off either by cold chisels, hack-saws or modern machinery invented for the purpose.

The metal fins formed at the joints of the moulds, excrescences due to straining of the moulds or imperfect workmanship, and the stumps of risers and ingates are generally removed by means of manufactured grinding wheels. The grinding machines used are of various designs, the commonest being the fixed foundation, horizontal spindle type with a wheel mounted at each end. Portable or semi-portable grinding machines of the pendulum pattern are becoming popular, and the small grinding wheel, operated by electricity through flexible wires, or by compressed air, is an exceedingly handy tool for dealing with bulky articles inconvenient to be brought to fixed machines.

Much dust and sand arise from all these cleaning processes, and ultimately most of it falls to the floor; indeed, the floor of a fettling shop is usually covered with sand to a depth of several inches, and walking thereon stirs up a cloud of dust of a very unpleasant nature. In a few shops the benches are perforated, and boxed in below, and a connection made to an exhaust system. This is a vast improvement, and should be adopted wherever possible. Attempts to draw off the dust arising from the operations on the benches by means of exhaust ventilation applied above have been tried, but not very successfully.

Two factors are concerned in the condition of the floor of a fettling shop—first, the large amount of sand and dust removed from the castings, and second, the difficulty of obtaining a suitable material for the floor so that it will resist the impact of heavy articles and will not cause fracture of fragile castings when dumped upon it. Consequently the floors are usually of earth, and proper cleanliness is most difficult.

It might be possible in some cases to solve the problem by constructing the fettling shop floor of grids or gratings so as to allow the sand and dust to fall through. Such a plan certainly seems worthy of trial in shops where light castings only are dealt with. Pending such experiments, the amount of dust in the atmosphere of fettling shops should be minimised by the maintenance of ample means of ventilation, and the thorough sweeping of the floors after adequate sprinkling with water.

General smoothing of the surfaces of castings is performed by either rumbling, or sand blasting, or a combination of both. A *rumbler*, known also as a *rattler* or *tumbling barrel*, is essentially a revolving vessel, into which the castings are placed, sometimes with the addition of stones, cast-iron "stars," of machine shop "burrs," the smoothing being accomplished by the repeated tumbling of the articles against each other and the added material.

The commonest type of rumbler is a barrel 3 ft. to 10 ft. long, of cylindrical, hexagonal or octagonal cross-section, revolving mechanically on a horizontal axis. A longitudinal portion, or stave, of the barrel is detachable so as to permit the insertion of the castings, and the barrel is frequently perforated so as to allow the free sand to fall out.

A rumbler is a notoriously dusty machine, both during working, when the dust escapes from holes or through the joints, and when the castings are being withdrawn; dust figures* 1,976 and 2,106 were obtained at points near rumblers. Some means of dust suppression or removal are very necessary, although not often provided at present. In some works the rumblers are enclosed by wooden housings connected to an exhaust system. Some rumblers are made with hollow trunnions, through which the dust is exhausted by means of a fan. In a few cases the rumbler revolves with its lower half in a tank of water, so that no dust arises; rusting of the castings is prevented if the water is made hot by the introduction of steam. Splashing of the water is prevented by a splashboard in front of the barrel.

Sand Blasting.

Cleaning and smoothing by sand blasting is specially suitable for articles too large for the rumbler, but owing to the rapid and inefficient results obtained, a great variety of castings, small and large, are now treated by this method. The expression "sand blast" is somewhat loosely applied in the trade, the term "sand" including chilled iron shot or grit, which is frequently employed as the eroding agent instead of sand. Broadly speaking, sand-blasting machines may be divided into two classes—(1) those in which the abrasive is confined under pressure and driven through a hose to a nozzle by direct constant pressure; (2) those in which the abrasive is brought by suction or gravity to the nozzle and then impelled by the air jet.

Most modern machines are arranged on an automatic system, which provides for the return of the abrasive material to be used over and over again after its separation from the dust arising from the castings.

The simplest application of the sand blast is that in which the castings is placed in the open air and its surface sprayed by the abrasive as the latter is projected from the nozzle of a flexible pipe held in the operator's hand.

Small articles are conveniently treated in a cabinet or chamber into which the flexible pipe with nozzle is led. The operator stands in front of the cabinet watching the operation through a small window or gauze-covered sight door. The cabinet is provided with two openings, loosely covered with canvas or rubber, for inserting or withdrawing the castings and to permit the insertion of the operator's hands to direct the blast or expose fresh surfaces of the castings.

* This book can be obtained from H.M. Stationery Office, Imperial House, Kingsway, London, W.C.2. Price 4/4 post free.

* Compare with figures ranging from 50 to 900 for hammer and chisel fettling.

Fig. 1 shows a sand-blast plant for large articles, a special room being provided for the installation. The room A is constructed of cast- or sheet-iron walls with hinged door. The roof is of glass, and artificial illumination is provided by bulkhead lights on the side walls. The floor is constructed of grids communicating to hoppers below, bogie rails being fixed to the floor if necessary.

The operator is stationed inside the room, and directs the blast upon the articles by the hose and nozzle N. C is the mixing chamber, made in three divisions, and D the dust settling chamber. Compressed air is supplied though the pipe E, which has a supply valve F. H is the sand-blast valve in the mixing chamber, and L, M, P are levers operating the air-suppply valve, sand valve and sand-blast valve respectively from inside the blast room. To start the plant, the compressed air valve F is shut off, and sand or shot placed in the upper part of the mixing chamber. The sand and air valves are then gradually opened until the required quantity of sand or shot issues from the nozzle N.

The used sand or shot, with the sand from the castings, falls through the hoppers, and is drawn up into the separator D. The lighter material is drawn off by the action of the fan, whilst the heavier material falls into the chamber C for re-use.

Ventilators are provided in the roof of the room, and the connection at K to the exhaust fan is intended to carry off any fine floating dust from the upper part of the room.

Other sand-blasting machines are made with rotary or reciprocating tables, and these are very useful for large castings awkward to manipulate in the ordinary way.

An efficient protection helmet, overalls and gauntlets are very necessary when the operator works inside a sand-blasting room or uses the blast in the open air. Various types of helmet are on the market, the common feature being the supply of compressed air for breathing by means of a pipe led to the top of the helmet. Care must be taken that this supply is pure, and a filtering device on the helmet is desirable. The expired air finds an outlet through the loosely-fitting part of the helmet over the operator's shoulders.

A combination of rumbler and sand-blasting apparatus has the blast directed through one or both ends of the slowly-revolving barrel, and the motion of the latter causes the castings to tumble over one another, thus continually bringing new surfaces under the action of the blast. The sand and dust escape through perforations in the barrel into the barrel box, and are drawn off under exhaust to the sand-blast apparatus. The latter is arranged and worked as in the case of the sand-blasting room.

All enclosed sand-blasting apparatus should be worked under a negative pressure inside the enclosure so that no dust may escape to the outside.

The nature of the sand derived from the castings is of considerable importance from the point of view of this inquiry. A moulding sand must necessarily possess plasticity, porosity and refractoriness—the latter quality being particularly essential with the higher temperatures employed in steel casting. To secure these properties a mixture of sand is usually made up, together with clay as a natural bonding substance, and more or less other bonding material such as flour, sugar, molasses or horse manure. The major portion is preferably a coarse sand of nearly pure silica with a bond of 2 to 5 per cent. of clay. The complete "moulding sand" for iron-foundry work usually contains 70 to 85 per cent. of free silica as quartz; in steel-foundry practice the silica content may be considerably higher. Sometimes the good quality sand is only used for the parts of the mould in contact with the pattern—such is termed "facing sand," and is brushed over with fine carbonaceous matter. The sand for cores is frequently of a different composition from that of the mould; also in the casting of large articles "steel makers' composition" is used, the formula for this "compo." being often a jealously guarded works' secret. The principal ingredient, however, in all the sands or mixtures employed is the free silica.

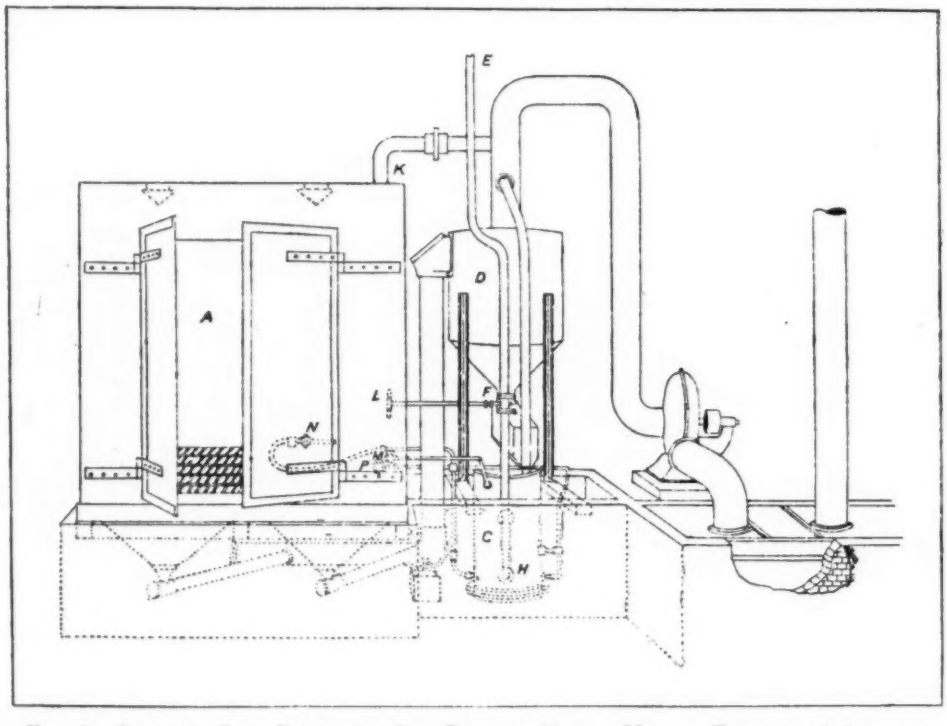

FIG. 1.—COMPLETE SAND BLAST AND SAND-BLASTING ROOM. MESSRS. TILGHMAN & COMPANY.

Medical Notes on the Cleaning of Castings.

The industries represented include manufacture of textile machinery, locomotives, ranges, rain water and soil goods, anchors, sewing machines, and machinery for steel works, collieries, and tin-plate works. The series includes workers from 31 different factories situated in England, Scotland and Wales.

The dust to which workers are exposed in the cleaning of castings is derived from (1) the moulding sand becoming detached from the castings in the processes of brushing, rumbling, coring and

handling generally; (2) the abrasive wheels, of emery or similar composition, used in the processes of "dressing" or "fettling," and (3) the general atmosphere of the place where the work is carried on. In addition, the process of sand blasting has to be considered. Where this is done in a special chamber, very little dust will escape into the atmosphere of the general workplace, but when the "table" form is in use considerable vitiation of the surroundings may occur if the locally applied exhaust ventilation is defective. Moreover, if non-metallic grit is used as the abrasive, a new constituent is added to the atmospheric dust.

While particles measuring 0.01 mm. are rarely found to have penetrated into the lung tissue, those of smaller size, 0.005 mm. to 0.001 mm. and under, must always be considered to be dangerous. There is some evidence that fine silica present in moulding sands is less injurious than similar particles to which a worker is exposed at the moment of fracture, as in grinding metals on sandstone, or crushing raw silica-rock, though the explanation of this is not clear. In the method of preparation of moulding sands, there would appear to be every opportunity for the cohesion of the finest particles with each other, and fixing of silica particles by aluminous particles in the bond seems probable. In the case of steel casting when the temperatures reached are high enough to alter the quartz of the facing sand to tridymite or to produce vitrification or other essential change, the dust probably loses much of its dangerous character.

Reference to the petrographical examinations shows a very high dust figure associated with a high count of small particles of 3 *microns* and under; the five following counts also refer to the cleaning of castings while the dust figures are also high and the particles are chiefly larger. It must be assumed that an important proportion of the particles consist of silica, and therefore exposure to such dust carries a hazard to workers.

The fact that the fine silica particles are inhaled in company with particles of carbonaceous matter derived from the crushed coal or coke in the moulding sand, and with aluminous particles from the bonding clay or the original sand itself, may influence the ultimate effect of silica particles when they reach the lung. The conditions are comparable in a measure to those which the coal miner is subjected to when working in a narrow seam and having to deal with dust from coal, siliceous rock, and fireclay. In such colliers, the clinical conditions vary with the nature of the dust they habitually inhale, and all degrees of fibrosis, on the one hand, and catarrhal conditions, on the other, are found.

SUGGESTED REGULATIONS FOR THE GRINDING AND GLAZING OF METALS AND CLEANING OF CASTINGS.

Nothing in these Regulations shall apply to grinding and incidental processes in, or incidental to, the manufacture of cutlery, edge tools, and other cutting and piercing implements of iron or steel, except grinding processes in the manufacture of needles, pins and fish-hooks.

Definitions.

For the purpose of these Regulations—

Grindstone means a cylinder of natural sandstone or manufactured sandstone. Or a metal cylinder into which blocks of natural sandstone or manufactured sandstone are fitted.

Manufactured Wheel means a wheel shaped in the cylindrical or other form, and manufactured of bonded emery or similar abrasive.

Glazing means the abrading, polishing or finishing, by aid of mechanical power, of metal, article of metal, or part of any article of metal by means of any wheel, buff, mop, bob, dolly, or band to which any abrading or polishing substance is applied.

Grinding means the abrasion, by aid of mechanical power, of metal, article of metal, or part of any article of metal by means of a *grindstone* or *manufactured* wheel.

Racing means the turning up, cutting or dressing of a revolving *grindstone* to obtain true rotation.

Hacking means the chipping of the peripheral surface of a *grindstone* by a hack or similar tool.

Rodding means the intermittent dressing of the surface of a revolving *grindstone* by the application of a rod, bar, or strip of metal to such surface, and comprehends such trade terms as "barring up" or "scaring."

Cleaning of Castings means the freeing of castings from adherent sand or other substance, and includes the withdrawal or knocking out of cores, core rods, and lifters, the removal of ingates, risers or other projections or excrescences, and the general smoothing of the castings, whether those operations are performed with or without the aid of mechanical power.

Rumbling means the cleaning or smoothing of castings by rotating them in a revolving vessel, and comprehends such trade terms as "rattling" or "tumbling" or "jigging."

Sand Blasting means the cleaning or smoothing of casting by a jet of sand, cast-iron shot, steel grit, or other abrasive, propelled by a blast of compressed air or steam.

Sand Blasting Room means a separately constructed closed room within which *sand blasting* is carried on and wherein no other work is ordinarily performed.

Duties.

It shall be the duty of the occupier to provide and maintain all appliances and water supply, when and where required by these Regulations. He shall also be responsible for the cleaning required by Regulation 8.

It shall be the duty of every person who is employed or engaged in any work to which these Regulations apply to make full and proper use of all appliances provided in pursuance of the said Regulations, and failure to report forthwith to the occupier, owner, or manager, or other responsible person in authority, any defect in the same, shall be deemed to be a breach of the said Regulations.

Regulations.

1. No *racing*, dry *grinding*, or *glazing* ordinarily causing the evolution of dust into the air of the room in such a manner as to be inhaled by any person employed shall be performed without the use of adequate appliances for the interception of the dust as near as possibly practicable to the point of origin thereof, and for its removal and disposal so that it shall not enter any occupied room, and for the purpose of this Regulation the appliances shall not be deemed adequate unless they include:—

(*a*) A hood or other appliance, so constructed, arranged, and placed as substantially to intercept the dust thrown off; and

(*b*) A duct of adequate size, air-tight, and so arranged as to be capable of carrying away the dust, which dust shall be provided with proper means of access for inspection and cleaning, and shall be kept free from obstruction; furthermore, where reasonably practicable, a connection shall be provided in every duct at the end remote from the fan to enable H.M. Inspector of Factories to attach thereto any instrument necessary for ascertaining the pressure of air in the said duct; and

(*c*) A fan or other efficient means of producing a draught sufficient to extract the dust;

or are such as, in the case of the particular factory or part thereof, or of the particular manufacture, process or operation in or for which they are used, shall be proved to be at least as effectual for such interception, removal and disposal as such hood, duct and fan would be.

2. Not more than one person shall at any time be allowed to perform the actual process of *grinding* or *glazing* upon any *grindstone*, *manufactured wheel* or *glazing* appliance, provided that this Regulation shall not prohibit the employment of persons assisting in the manipulation of heavy or bulky articles at any such *grindstone*, *manufactured wheel* or *glazing* appliance.

3. *Glazing* or other processes, except operations incidental to wet *grinding*, shall not be carried on in any room in which wet *grinding* on a *grindstone* is done.

4. In every room in which wet *grinding* on a *grindstone* is carried on, exhaust and inlet ventilation shall be provided and mantained whilst work is in progress so as to ensure that the air of the room is renewed not less than 12 times per hour. The ventilation shall be arranged in such a manner as to secure a continuous movement of

air away from the grinder and towards the *grindstone*. Fresh air inlets shall be so arranged and shall be of such dimensions that no worker is exposed to a direct draught from them.

5. Wet *grinding* upon a *grindstone* shall not be done except with a supply of clean water conveyed by pipes and deposited upon the surface of the *grindstone*, and suitable arrangements shall be provided to ensure the drainage of the waste water from the *grindstone* trough.

6. *Hacking* or *rodding* shall not be done unless with an adequate supply of water laid on at the upper surface of the *grindstone*, and arranged so as to ensure as far as practicable the suppression of dust during the process.

7. Wet *grinding* upon a *grindstone* shall not be done in any room in which—

(*a*) The height of the room, measured from the floor to the lowest part of the top, is less than 10 ft.; nor

(*b*) In which the total window area is less than one-sixth of the floor area; nor

(*c*) Unless all windows are properly glazed and the glass or other material of such windows maintained whole and kept clean.

8. In every room in which *grinding* on a *grindstone* is done the floor, walls, ceiling or top and all other parts of the room and fixtures shall be properly cleaned at least once in every three calendar months.

9.—(*a*) The person performing the cleaning required by Regulation 8, or the person in charge when more than one are employed shall enter in a prescribed register, at the conclusion of the work, the prescribed details of the cleaning together with his signature.

(*b*) The prescribed register shall be kept so as to be available for examination at all reasonable times by H.M. Inspector of Factories and by any workman engaged in any room to which the said Regulation 8 applies.

10. No person employed at *grinding*, *glazing* or processes incidental thereto shall spit upon the floor, walls or any part of any room in which *grinding*, *glazing* or processes incidental thereto are carried on, nor into or upon any apparatus, plant or fixtures in any such room.

11. In every room where *cleaning of castings* is done the floor shall be damped and swept at least once every day. Provided that the Regulation shall not apply to cleaning of castings done upon the foundry floor at the place where the metal for the said castings is poured.

12. There shall be provided and maintained for the use of all persons employed in *grinding* or *cleaning of castings*—

(*a*) A suitable place or places for clothing put off during working hours;

(*b*) A suitable place or places for the storage of overalls, which place or places shall be separate from that required by paragraph (*a*) of this Regulation.

13. There shall be provided and maintained in a cleanly state and in good repair, for the use of all persons employed in *grinding* and *cleaning of castings*, a lavatory under cover, with a sufficient supply of clean towels, renewed daily, and of soap and nail brushes, and with either—

(*a*) A trough with a smooth impervious surface fitted with a waste pipe without plug, and of such length as to allow at least 2 ft. for every five such persons, and having a constant supply of warm water from taps or jets above the trough at intervals of not more than 2 ft.; or

(*b*) At least one lavatory basin for every five such persons, fitted with a waste pipe and plug, or placed in a trough having either a constant supply of hot water and cold water or warm water laid on, or (if a constant supply of heated water be not reasonably practicable) a constant supply of cold water laid on, and a supply of hot water at hand when required for use by persons employed.

14. In every room in which *grinding* is carried on there shall be kept permanently affixed a notice specifying the safe working peripheral speed of every class of *grindstone* and *manufactured wheel* in use in such room. Such notice shall specify also the speed of the driving shaft or shafts, and the diameters of the pulleys necessary to secure such safe working peripheral speed.

The occupier or his agent shall, when required by H.M. Inspector of Factories, give all necessary facilities and particulars to enable him to determine the speed of any prime mover, shaft, pulley or other appliance.

15. *Rumbling* shall not be done unless:—

(*a*) The rumbling appliance is provided with efficient exhaust draught arranged and maintained so that any dust evolved is prevented from entering any occupied room; or

(*b*) Such arrangements are made as shall be proved to be at least as effective in preventing the said dust from entering any occupied room as the means required by (*a*).

16. *Sand blasting* shall not be done in any room except in a *sand blasting room* or chamber or cabinet, nor in any *sand blasting room*, chamber or cabinet unless efficient means are provided, arranged and maintained to prevent the escape of dust to the outside of such *sand blasting room*, chamber or cabinet.

17. No person shall be allowed to perform *sand blasting* or to assist at *sand blasting* in the open air, or be allowed to work within 30 ft. of *sand blasting* apparatus in operation in the open air, or be allowed to work or remain in a *sand blasting room* whilst the *sand blasting* apparatus is in operation, unless he is wearing an efficient protection helmet, overalls and gauntlets.

18. The occupier shall provide and maintain in a clean and efficient state a protection helmet, overalls and gauntlets for the use of each person performing *sand blasting* or assisting at *sand blasting* or working within 30 ft. of *sand blasting* in the open air or working or remaining in a *sand blasting room* while the *sand blasting* apparatus is in operation.

19. A protection helmet shall not be considered efficient unless—

(*a*) It carries the distinguishing mark of the person to whom it is issued and by whom it is intended to be used; and

(*b*) Such helmet is provided with a sufficient supply of pure air for breathing and ventilation, together with suitable arrangements to permit the escape of the expired air.

20. No person shall wear a protecton helmet that has been worn by another person unless and until such protection helmet shall have been thoroughly disinfected.

21.—(*a*) All ventilating plant used for the purpose of extracting or suppressing dust shall, at least once in every six months, be examined and tested by a competent person.

(*b*) The competent person shall record in a register particulars of his examination and tests, and the said register shall then be delivered to the occupier or his agent, unless the occupier or his agent be the competent person, and the said register shall be available to H.M. Inspector of Factories on demand.

22. The occupier or his agent shall, on receipt of the record of examination and tests made in pursuance of Regulation 21, or on completion of such examination and tests where the occupier or his agent is the competent person, take immediate steps for the rectification of the defects, if any, disclosed by such examination and tests, and he shall certifiy upon the record made in pursuance of Regulation 21 the date when such rectification is completed.

Exemptions.

If at any time it shall be shown to the satisfaction of the Chief Inspector of Factories in the case of any manufacture, or process, or any operation forming part thereof, that either—

(*a*) Dust is not created to an appreciable extent; or

(*b*) Injury to health is adequately prevented by other appliances, or under other conditions, than those prescribed by these Regulations; or,

(*c*) The application of these Regulations, or some part thereof, would, for any reason, be impracticable

the Chief Inspector of Factories may, by Order, exempt such manufacture or process from the whole or any part of these Regulations, and either absolutely or subject to such conditions as may, in such Order, be prescribed, and may at any time amend or revoke such Order.

An Apprenticeship Course in Foundry Practice.—XLVIII.

By Ben Shaw and James Edgar.

MOULDING MACHINES.

Labour-saving devices invariably meet with some form of resentment at their inception, and frequently for years afterwards. This attitude is apparent in some foundries to-day in connection with moulding machines, but apprentices should make themselves familiar with all appliances that are especially designed to cope with modern requirements. In comparison with the engineering trades the foundry has unfortunately been neglected in the design and equipment of machinery to enable it to keep abreast of modern times. Too much concentration, in comparison, has been focussed on the mechanical means for finishing products expeditiously, rather than on those that form a part of the finished product. Considerable improvement has been made, however, during recent years, particularly in this country, and foundries are now more alive to the need for mechanical appliances with a view to the rapid production of castings economically. Mechanical appliances are instrumental in assisting the performance of two important functions—they speed up production and reduce manual labour. This is equally true of the mechanical appliances used in the foundry, and particularly of those to which we purpose making special reference in this article, namely, machines especially designed to deal with the production of moulds. The use of machines to increase the rate of production should be of mutual benefit to employer and employee, because the more rapid production reduces costs which invariably increase the demand for the articles produced, and the laborious nature of the work is reduced. Moulding machines do not dispense with the need for skill, and they are never likely to, however ingenious the devices may be, but they do assist in reducing the less skilled operations.

Primarily, moulding machines are designed to cope with work of a repetition character, and, with few exceptions, they are not likely to be economically employed unless the number of castings of similar design warrant the additional outlay in preparing a first-class pattern for use with a machine. The exceptions refer particularly to those machines that only ram the sand in moulds and which are usually referred to as moulding machines. Generally it may be assumed that moulding machines are more applicable for repetition work, and the greater the number of castings required of any one design, the lower will be the cost per casting produced, because the high cost of the preparatory pattern work, suitable for a machine, will be spread over a greater number of castings and become less appreciable.

In addition to the greater speed of production from moulding machines, the resulting castings are more accurate, cleaner and possess a more regular surface than is obtained from hand-made moulds. The reduction in the amount of rapping necessary, because of the accuracy of stripping appliances, reduces any variance in weight, between castings from the same pattern, to a minimum, and, as no patching is necessary, the castings are well defined and an exact counterpart of the patterns used.

Types of Machines.

Moulding machines may be classified as hand and power machines, and each class may be divided into various types. The operations performed by the machines are somewhat similar in each class. The hand machines, for instance, may be either hand, press, or jolt ramming machines. Invariably each of these types have facilities for mechanical stripping by some form of lever appliance capable of being operated by hand, and in addition some can be fitted with turnover attachments and draw frames.

The hand machines have a special value in that they do not incur the expense of installing power plant and its maintenance. They can be operated economically and carry much less overhead charges in comparison with power machines, and are useful when the speed of production will meet the demand for castings. These machines possess the advantages for small work that are credited to power machines, but, because more energy is expended by the operator, they are, as a rule, slower.

The power machines, while, in the main, consisting of similar types as hand machines, vary considerably in the kind of power employed. There are the squeezers or press machines and those that ram the sand by means of a jolt or jarring action, each of which invariably have facilities for pattern drawing and sometimes for turning over. The power employed for operating these machines may be steam, pneumatic or hydraulic pressure, and more recently machines have been designed that are operated electrically. The use of steam is not now so prevalent as formerly. Machines that are operated with this power have the disadvantages of hot pipes in the vicinity of the operator, and escapes are not only troublesome, but dangerous. Some types of machines have been demonstrated to be capable of doing efficient work under electrical power, and there seems every prospect of a profitable future for machines so operated, because the consumption of power can be localised more satisfactorily, but the majority of power machines are operated by either hydraulic pressure or compressed air. Much diversity of opinion exists as to most suitable power to use. Practically all large works have a general power plant for operating machines, and it is frequently more economical to install moulding machines to suit the power available, but the cost of installing a suitable compressor and its maintenance to provide a pressure from 70 to 100 lbs. per sq. in. is greater than that of a hydraulic accumulator and pump. With the latter a pressure from 750 to 1,250 lbs. per sq. in. can easily be obtained for the purpose. Hydraulic pressure is used many times greater than pneumatic pressure, and the power dimensions of machines can be reduced while still retaining greater relative power than machines operated by compressed air. Waste of power due to leakages increases the overhead charges and, as air leakages are not troublesome, they are likely to be overlooked; on the other hand, the leakages in a hydraulic system, because they are troublesome, are more likely to be attended to expeditiously. The higher pressure of water gives better control, especially during the time of stripping.

Hand Ramming Machines.

There are a number of different kinds of hand ramming machines, but in this article we will confine ourselves to representative types and leave the apprentice to familiarise himself with those forms with which he is likely to come into contact. Although classed as a moulding machine, this type is really a stripping machine because the manipulation of the sand is done by hand. A familiar form of such a machine is illustrated in Fig. 1. This represents the standard machine of the Adaptable Moulding Machine Company. Two sizes are made capable of taking boxes varying from 12 in. to 20 in. in width and 18 in. to 26 in. in length respectively. The length of plates that may be used with this machine is practically unrestricted. The machine as illustrated is closed to its minimum size of 12 in., but the end frames carrying the adjustable strips, on which the moulding box rests while being rammed, can be moved by means of an extension key operating a left and right-handed screw to take plates within the capacity of the machine. The illustration shows the machine with a reversible pattern plate in position which is secured to uprights controlled by the draw handle. This machine allows for a 6-in. draw, but additional fitments can be obtained for 9-in. or 12-in. draws.

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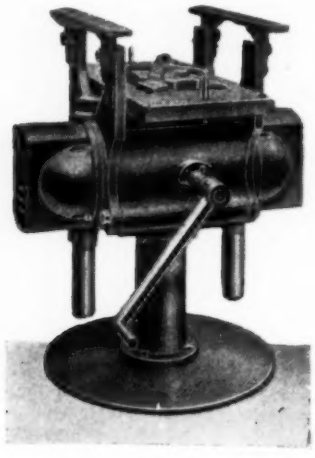

Fig. 1.

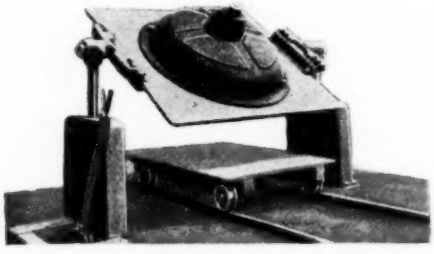

Fig. 2.

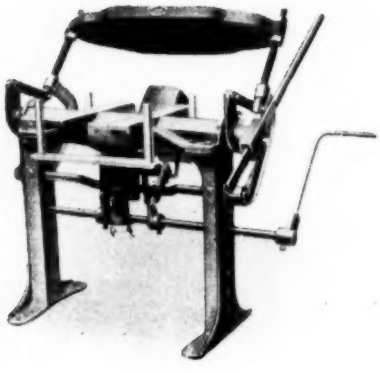

Fig. 3.

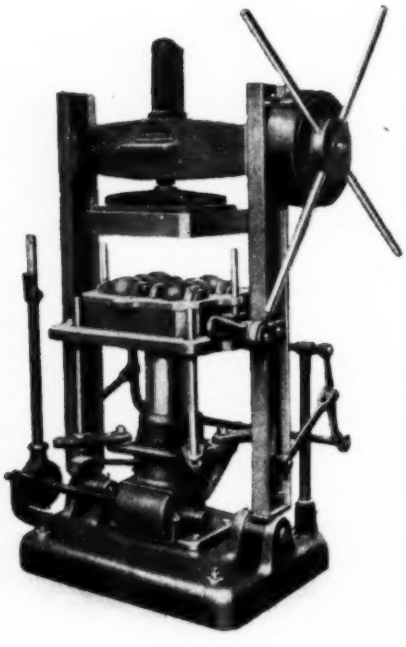

Fig. 5.

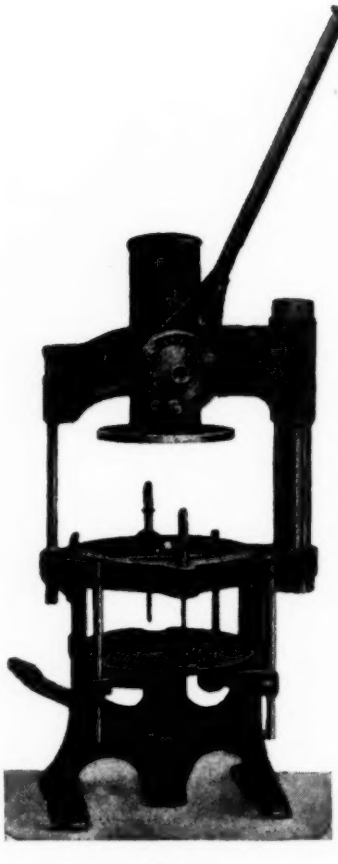

Fig 4.

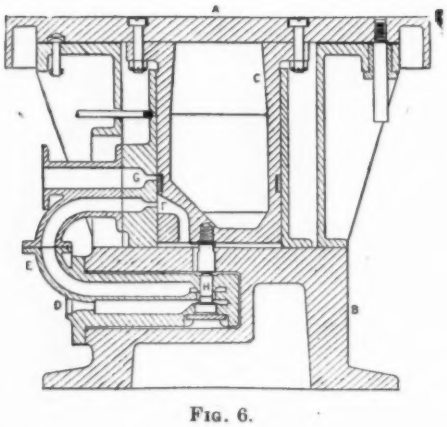

Fig. 6.

and an appliance for turning is also incorporated with the design. By moving the draw-handle the plate is lifted so that its joint coincides with the top of the adjustable strips upon which the box parts rest. The box part is registered on the plate and rammed up. By operating the draw-handle, after any preliminary rapping that may be necessary, the pattern plate is stripped in a perfectly true and accurate manner. With a reversible plate, such as is shown in the illustration, there is no necessity to change the plate until the required number of moulds are prepared, successive pairs being assembled at once for casting.

Another hand ramming machine is illustrated in Fig. 2, and is made by the General Foundry and Engineering Company, Limited. The object of this machine is to provide deep, accurate and variable draws. The pattern plate is raised and lowered by means of long connecting rods, hinged to an intermediate part of the shafts at their upper ends, whilst their lower ends are connected with long cranks on a horizontal shaft. The horizontal shaft is contained in the base of the machine, which is bedded in the floor to bring the rails flush with the floor level. A variable draw is obtained by a rack and pawl device, enabling the lift to be regulated to suit the depth of pattern. The pattern plate is carried by trunnion brackets mounted on trunnions carried to the upper ends of the vertical shafts. It is locked in a plane at right-angles to the axis of the vertical shafts in order to effect an accurate draw. The rails for the moulding box trucks are provided with the machine.

Hand Press Machines.

The various forms of hand press or squeezer machine are more numerous than those involving hand ramming. They are operated very quickly and are especially effective for small or shallow work. Fig. 3 illustrates a machine of this type made by the Britannia Foundry Company. The press is operated by a hand lever at the side, and on this machine a total pressure of about a ton is obtained without unnecessary effort on the part of the operator. In this instance the pattern plate is maintained in a fixed position, the box part being lifted, when stripping, by an arrangement of levers on a spindle operated by the lower handle on the side.

Another form of hand press machine is illustrated in Fig. 4. This represents one of Bonvillain and Ronceray hand-moulding machines. The sand is consolidated by means of a long lever operating a pinion and rack which gives considerable mechanical advantage. This can be adjusted to suit the depth of box to be pressed. The head of this machine can be moved by disengaging the tie bolt at the front, it can then be swung out of the way for stripping. The appliance for lifting the box from the plate is operated by the foot lever pedal shown in the illustration.

A more elaborate form of press machine is illustrated in Fig. 5. This machine, which is made by the Britannia Foundry Company, is capable of adjustment for varying sizes of plates within its capacity. The press is mechanically geared and operated by the star wheel at the side, and a total pressure of approximately five tons can be obtained without excessive exertion on the part of the operator.

With all press machines of a type similar to those mentioned a loose frame is used on top of the box part as an extension piece to enclose the quantity of sand to be pressed and into which the press head will enter as the pressure is applied. In consolidating the sand by pressure in this way it is important to maintain the pressure sufficiently long to enable air to escape. This will make the matrix firmer.

Jar Ramming Machines.

Opinions differ considerably on the important question of ramming the sand mechanically. With the press or squeezer type of machine the density of sand is likely to be greatest nearest the press head, and the varying depths so rammed have a varied density. This difficulty is not appreciable in shallow moulds, but as the depth to be rammed increases, so does the difference between the density of sand next to the press head and that forming the face of the mould. Thus the effectiveness of the press machine is reduced as the depth of the work increases, unless the mould is pressed at intervals instead of at one operation, and this necessitates special press heads or ramming plates to suit the boxes and the work. This difficulty led to the introduction of the jolt- or jar-ramming machines, coupled with the fact that, especially with pneumatic pressure, the requisite pressure for large surfaces also presented difficulties. The principle on which these machines operate is the jar produced by a falling mass suddenly brought to rest by impact against a stationary body. The jarring action produced in this way consolidates sand in a box, but, in this case, greater density is given to that nearest the plate upon which the box rests. The density of sand is determined by the number of jolts, and is under the control of the operator. This type of machine can be obtained operated by hand through the medium of a lever and cam arrangement, but it is more commonly associated with power in the form of compressed air. A typical jar-ramming machine is shown in section in Fig. 6. The table A is secured to a piston or plunger C which fits accurately into the air cylinder. A casing about the cylinder is secured to the anvil or base-block B. The air inlet is through D and the lift pressure through F. The lift cuts off the pressure and the air is exhausted through G, when the piston falls back, which operates a valve at H. This valve controls the re-entry of the compressed air and forms a cushion which reduces the effect of the jarring action on the machine and on surrounding work.

It is evident from the number of these machines in use that jar-ramming possesses many advantages. The difference in sand density is not very marked, but the greater density is next to the face of the mould in planes parallel to the box joint. The method is used satisfactorily for large bodies of sand as well as small. Many of these machines are designed to perform the ramming operation only, having a flat table on which the pattern or pattern section is placed and the box part located Sand is then introduced mechanically or by hand and the machine operated until the mould is wholly rammed. The utility of this type of machine ceases when the mould is rammed, the stripping of the pattern being done by hand as in hand moulding. In varying sizes this machine is suitable for jobbing foundries when only a few castings may be required from any one pattern and it is not profitable to prepare the work for mechanical stripping. A very large machine of this type is illustrated in Fig. 7. It is made by Macdonald & Son, and is known as a plain jar-ramming machine. The effect of the shock on the base is taken up by pressure cushions in the columns shown, and these reduce the vibration and its evil effects upon other work near the machine. These machines are more suitable when the joint of the pattern coincides with the joint of the mould and moulding box, but the joint may be cut after ramming as in hand moulding.

Another machine of similar type, in that it is a jar-ramming machine, but having facilities for pattern drawing, is illustrated in Fig. 8. It is made by the same firm. It will be noticed that it is capable of adjustment to accommodate varying sizes of boxes. This is a jar-ramming and stripping machine.

One of the latest machines of the Britannia Foundry Company is illustrated in Fig. 9. This is a similar type of machine, but having, in addition to facilities for stripping, an appliance for turning over. This has been designed more especially for making moulds of a repetition character that require a turn-over table. The mould is lowered from the turn-over table by a piston working inside the jarring piston, and consequently it is not liable to get out of alignment. It is made in three sizes, the illustration showing the intermediate size, which has a draw of 1 ft. 3 in. The piston for drawing the pattern is operated by oil through the air pressure. This method ensures a steady draw comparable with that obtained on a hydraulic machine.

Power Press Machines.

Press machines operated by pneumatic or hydraulic pressure are not likely to be readily

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FIG. 7.

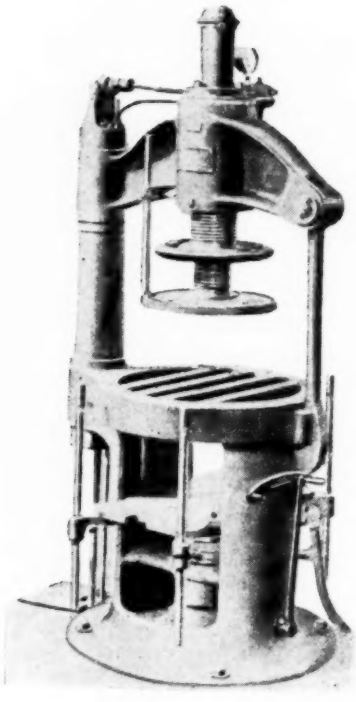

FIG. 10.

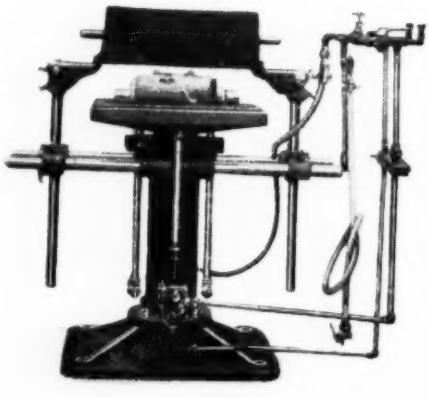

FIG. 8.

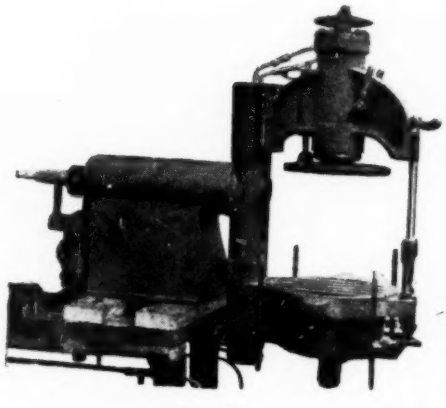

FIG. 11.

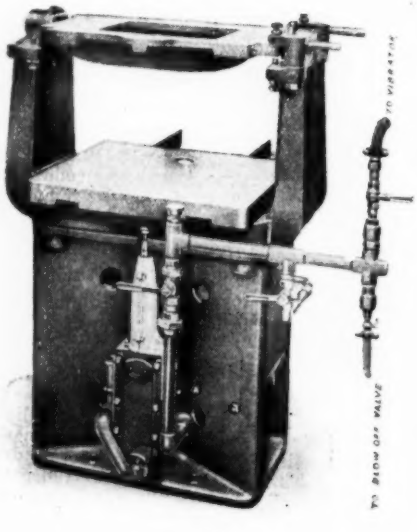

FIG. 9.

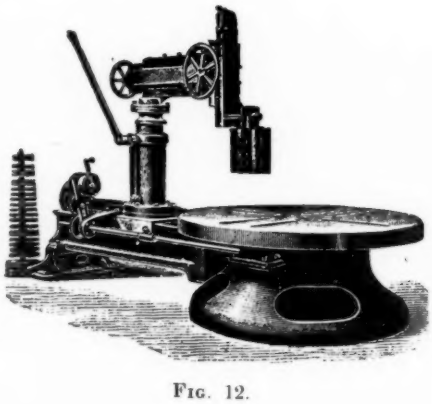

FIG. 12.

displaced for making moulds. They are both rapid in operation and practically free from vibration, such as is likely to affect other moulds in their vicinity. The operations of power press machines are based on similar principles as the hand press machines, but, since mechanical power is employed, the energy expended by the operator is trivial in comparison, and the moulds are not only more effectively rammed, but are prepared more expeditiously. The use of power also increases the size of work that can be accomplished with ease. Compressed air is used considerably for machines capable of dealing with small work, while both large and small machines are operated by hydraulic pressure. The latter has greater pressure and is more easily obtained, is more effective, especially over large surfaces, and gives better control. Fig. 10 illustrates a type of machine made by Bonvillain & Ronceray. The machine is one of six different sizes of the same type. The table, to which the pattern plate is fixed, has a large hole in its upper surface, which contains movable bars for supporting the pattern plate, and also to facilitate a clearance for loose stools for internal stripping. A swinging ramming head is mounted on a hollow column fixed on one side of the table which contains the power ram, with an adjustable socket and ram plate to give varying distances between ram plate and pattern plate. This obviates unnecessary movement of the ram. The ram is operated by a valve fixed to the swinging head, the water pressure being conveyed through the hollow column from a main valve attached near the base of the machine. The exhaust water is also conveyed through the column. A small cylinder placed directly over the ram cylinder in the swinging head is used for lifting the ramming head after pressing the mould. The swinging head is provided with a hook at the opposite end to the column which engages a slot in the table and supports the head when pressure is applied.

The pattern drawing arrangement consists of a cylinder fitted in the base of the machine which operates a piston carrying a lifting table. This table supports stools under the stripping plate. The piston, in this case, is controlled by a foot pedal which operates a valve in the main distributing chamber. This causes the table to ascend or descend at will. At the four corners of the lifting table are brackets through which the lifting rods pass and which enable adjustment to suit the height of lift required. These machines can be provided with a bottom ramming device.

A somewhat similar type of machine to the above, but designed for turning over, is manufactured by the same firm. It is illustrated in Fig. 11. This machine is mounted on a trunnion in order that it may be turned to an upside down position. The arrangement is particularly useful in cases where heavy pockets of sand have to be lifted. The use of a rotary machine of this type reduces the need for gaggers. The machine is rotated by means of a cylinder which is controlled by a lever shown at the left of the illustration.

Special Machines.

Various kinds of machines are designed to cope with special kinds of work, a typical example being Whittaker's moulding machine illustrated in Fig. 12. This is for preparing moulds for different forms of gear wheels. The moulds are prepared by hand, the machine carrying the pattern section for the teeth, by an arrangement of gearing capable of being varied to suit the diameter and number of teeth of the wheel to be made. Wheels up to 20 ft. dia. can be made on this machine. Besides ordinary spur and bevel wheels, double helical teeth are readily moulded, and accuracy is assured as far as the operations of the machine are concerned. There are many machines that do this type of work varying much in design, but for a similar purpose, namely, the accurate division of the moulds for teeth on wheels.

A totally different type of machine, and one which can certainly be classed as a moulding machine, is the Beardsley-Piper sandslinger. This is one of the most modern machines specially designed for the foundry. The principle upon which it works is the throwing of sand at such a force that the impact compresses it. There are two main types of this machine, a portable type suitable for jobbing foundries and a tractor type which travels into the sand heap under its own power. This latter type of machine, which is illustrated in Fig. 13, is suitable for ramming the sand in moulds placed at each side of it. Thus the machine is carried to the boxes, and after the work has been cast, the boxes and sand are at hand to proceed with the work. The machine cuts and mixes the sand on the floor from which it is conveyed to a riddle and then by another form of conveyor to an impeller by which it is thrown vertically. The control is at the end of the long

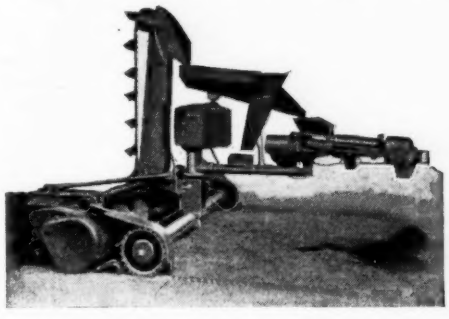

FIG. 13.

arm near the impeller, and the machine is very flexible with a wide radius of action. It is capable of dealing with sand and ramming it at the rate of about half a ton a minute, and no special patterns or box equipment are required.

This must not be considered as an attempt to cover all the machines that are used for moulding, but only a few of the more representative types are given in order to help the apprentice to realise that moulding machines have come to stay, and, rather than show resentment towards them, he should work them and endeavour to improve upon them. Like machines used in other crafts, they all have limitations, and by giving the design of existing machines careful attention, there is no reason why apprentices should not be instrumental in bringing about further improvements, either in existing types or in the design of new types of machines.

Book Review.

KELLY'S DIRECTORY OF THE MERCHANTS, MANUFACTURERS AND SHIPPERS OF THE WORLD. Published by Messrs. Kelly's Directories, Limited, 186, Strand, London, W.C.2. Price 64s., post free.

The directory is in two volumes, the first of which deals with foreign countries, and the second gives information concerning England, Scotland, Ireland and Wales and the British Dominions and Possessions. Under each town heading are given, in classified lists, the names (arranged alphabetically) of all those engaged in trade and commerce, with the class of goods in which they deal. The size of the book can be gathered from the fact that it contains some 5,000 pages, and gives information as to 20,000 foreign and Colonial cities and towns, under which over 1,500,000 trade descriptions are given. Obviously the utility of such a book largely depends on the indices, which in this case are of such a character that all vital information is instantly accessible to the reader.

Innumerable alterations have been incorporated in this edition, and in the present edition an alteration has been made in the section dealing with Canada, where, to facilitate reference, the towns and cities in Canada are now arranged in one alphabetical list throughout the Dominion, indication being given in each case of the province.

It can safely be said that the latest edition more than ever merits its popular title, "The Key to the World's Commerce," and foundrymen and metallurgists, using the book intelligently, will find it a distinct aid to the securing of trade connections in overseas markets.

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Discussions on Manchester Conference Papers.

DISCUSSION ON PROFESSOR SIEGLE'S PAPER ON CARBON IN FOUNDRY IRONS AND CASTINGS.

This Paper was read in abstract by MR. ROBT. BUCHANAN, a Past-President.

In a written communication MESSRS. W. G. MORGAN and E. M. CURRIE said:—

M. Siegle has given a very comprehensive survey of a very debatable subject, and taken as a whole his paper is worthy of commendation.

Graphitisation is such an important subject that every quota of information that will help to explain some of the apparently inexplicable troubles in castings will be welcomed. Although the Author states that irons widely different in total carbon present the same appearance of fracture and similar mechanical properties when the silicon content is such as to compensate the difference in carbon, it should be remembered that increasing the silicon content of a low carbon iron will not produce an easily machineable metal, and also that the form of the graphite determines the machineability of the iron. This is important, because although annealing will convert the whole of the carbon to the graphitic condition, yet if the original percentage of combined carbon was high, the form of graphite precipitated will be small, and compared with naturally large flaky graphitisation as would take place in the cooling of a high carbon iron, the metal would prove harder to machine.

The results of Prof. Turner's research quoted, are of great value scientifically in enabling the effect of silicon on carbon to be understood, but as iron with less than 2.5 per cent. total carbon is seldom met with in ordinary practice, it is to be regretted that more definite information is not available on irons with between 2.75 and 3.75 per cent. total carbon.

Difficulties of the Classification of Pig Iron.

For ordinary working the classification of pig-iron by its silicon content is sufficient if the maker is reliable, but in certain cases it is necessary to consider all the other elements as well, carbon being the foremost. Cast iron is such a heterogeneous material that it is impossible to control it by any one impurity alone, especially when the various impurities are interdependent.

With coke of such variable composition as is being supplied at present, the control of the sulphur warrants more consideration than it should be necessary to give it if working conditions were more stable. In view of the fact that satisfactory results have been obtained with iron of widely different sulphur contents, it does not seem advisable with present knowledge to take up any dogmatic attitude with regard to any particular percentage to use.

A laboratory is expected to work with reasonable accuracy and the possibility of involuntary errors in chemical analysis as mentioned by M. Siegle should, with reasonable care, be entirely eliminated.

Silicon and Graphite Precipitation.

MR. E. L. RHEAD said the Paper was of a character that should appeal to every foundryman, and it appealed to him particularly because it put a somewhat new aspect on the method of consideration of material at hand. It was presented in a different form, and while, perhaps, not embodying a very large amount of entirely new work, it did help them—he thought somewhat largely—to understand the question from the point of view of the foundryman. He was afraid the foundryman had been in the habit of looking askance at chemical work generally, and of assuming that, with very few exceptions, he could get along without any exact knowledge of the composition of the material he was supplying. The main point of the Paper appeared to him to be the consideration of the condition of the graphite in the casting as affected by other materials. M. Siegle pointed out that the total amount of carbon, in the first place, was as largely responsible for the amount, size and distribution of the graphite, as well as the presence of other substances, particularly silicon and manganese. Here he wished to call attention to one point that had been under investigation at the Manchester College of Technology for a considerable time. Progress had been slow, but he thought they were beginning to see a little daylight. It had been usual, as stated in the Paper, to assume that the total amount of silicon present in iron was responsible for the extent to which the carbon was separated from the metal. Within certain limits they agreed with that statement, and they had themselves, from time to time, used comparatively large quantities of silicon, up to 3½ per cent. or a little more, to modify the changes which took place in castings during solidification, with a view to utilising the effect of the graphite in preventing contraction when separating from the metal. But when dealing with very large castings, particularly those which required to have a very high tensile strength, they found that when it became necessary to cut down the silicon in order to avoid the separation of the graphite in that way, they still, under some circumstances, got the graphite separated, and the castings did not give the results anticipated. This occurred too frequently to admit of the explanation that it was purely the effect of the quantity of silicon which was present. Ultimately, as the result of a considerable number of observations on those lines, they formed the idea—he would not say they came to the conclusion—that for every grade of iron there was a particular percentage of silicon that would determine the precipitation of the graphite. In some cases they had found that with less than 1 per cent. of silicon practically the whole of the carbon had been precipitated in the graphitic form, while in other cases more than 2 per cent. of silicon had been necessary to secure anything like the same degree of precipitation. He thought that fact was not commonly recognised by founders. They hoped some day to be able to present in a very definite manner the effect of silicon in that direction.

Phosphorus and Carbon Precipitation.

The phosphorus content of the metal had been considered in connection with the precipitation of carbon. From the observations they had made there was no doubt that the presence of phosphorus had a distinct effect in increasing the size of the graphite flakes, even if it did not effect complete precipitation of the carbon.

In connection with the solution of the graphite, or the taking out of the graphite, during melting, the statements in the Paper relating to the solution of graphite in air furnaces and in cupola furnaces were quite distinct. In both cases perhaps some attention must be paid to the point he wished to mention. There were distinct differences in the total graphite present in the castings. Some of the graphite was of a type that would dissolve readily; other graphite was of a type which did not dissolve readily. In some cases in pig-iron one type of graphite preponderated, and in others it did not. When one introduced some graphite of the first type which was difficult to dissolve, it would be found sometimes that the graphite separated in cavities as a distinct loose powder, not simply embedded or as kish, but separated and concentrated in the cavities. That type of graphite did not dissolve readily in the iron during melting. The type of graphite that did dissolve readily in iron during melting was a type that separated out in the normal method of solidification. It was purer,; it was freer from other substances. Work was now proceeding on the composition of graphites that were separated from cast iron, and they were finding very distinct differences. The carbon that dissolved freely in the cast iron was different in character, in composition, from that which did not. He would suggest that, particularly in high silicon irons, there was a tendency for the graphite to float away during the melting of the iron rather than to be dissolved. If the melting of the iron took place slowly and not at high temperature, the graphite that was difficult to assimilate would float away and be to a certain extent removed from the metal. It was found frequently in the slag of the cupola as the result. So in air furnaces melting the floating up in solution of the graphite to some

extent explained the lower carburisation of the metal melted in that way as compared with that melted in the cupola. So one obtained a distinct difference in the type of graphite.

Sulphur in Cast Iron.

Not long ago they attempted to determine the comparative effects of sulphur and silicon in the opposite directions, and they came to the conclusion that there was here also a divergence in the type of iron. Sulphur had somewhere between 10 and 19 times the effect of the silicon in the opposite direction of causing the retention of carbon in the combined form, and thus making the iron whiter and closer and more liable to shrinkage in the castings. With regard to the effect on the size of the graphite, he had something to say to the Mechanical Engineers some years ago in connection with the effect of graphite in reducing the strength of castings, and he must refer the members to that on that particular point.

Difficulty of Obtaining Representative Samples.

DR. LONGMUIR said the Paper was a most welcome one to the Institute, and they ought to thank their French friends for bringing it forward. If they took the opening paragraph, in the reference to tensile stress and transverse, ease of machining, and resistance to shock, they got the essentials which were required in cast iron. As a whole the Paper was a very eloquent plea for analysis, and whilst chemical analysis would not solve every foundry problem it was, to put it in foundry language, a mighty good tool, and used as a tool it would help very considerably.

The author stated there were difficulties in carbon determinations plus or minus 0.05 per cent. There was no difficulty in any carbon determination of getting within the limits of plus or minus 0.05 per cent.; the difficulty was that, unfortunately, cast irons, especially when in pig form, varied from point to point over the length and from point to point across the section. Apart from that, the determination of any point offered no difficulty.

He was very keen on having in all cases as low a total carbon content as possible. That was a doctrine which was being preached—he thought wisely preached—in regard to sulphur, but as he grew older and got increased experience he could not help but come to the conclusion that the influence of sulphur had been very much overrated and that it was not as harmful as was generally thought. Whenever a defective casting was got people had been accustomed to ask, "What is the sulphur in that casting?" But the cause of blow-holes and the cause of defects in general could not always be attributed to sulphur.

No Bad Iron.

MR. BUCHANAN said the longer he lived the more he was in agreement with the statement which Thomas D. West made quite a number of years ago, that there was no good iron and no bad iron, it all depended on what one was going to do with it. If a parcel of hematite was handed to a man making light castings he would be in Queer Street very soon; if phosphoric iron was handed to a man who was going to make steel castings he would be in a similar predicament. So one had always to bear in mind, with regard to the quality of the iron and so forth, the purpose to which it was going to be put. One might say to make machinable castings was a matter of simplicity, but to get up to the high tensile required they had got to know the material much more closely than if they simply wanted softness; they could get softness if they kept the silicon up and the sulphur down; but in stronger test-bars the sulphur always inevitably went up because the silicon necessarily had to come down to get the closeness of structure which was necessary. He was at a meeting of the British Cast Iron Research Committee a few weeks ago when a chemist stated that as regards strength there was as much—he thought even more—in the structure of the metal as there was in its chemical constitution. He agreed with that statement. No matter what metal it was, they would never get strength if the grain was large. They would get softness but not strength. Especially was it so in cast iron; one had to close the structure even more religiously than attend to the chemical composition. A non-scientific ironfounder was speaking to him the other day. He was unused to getting test-bars, and did not know the way to get them. He had got an expensive iron, but his test-bars went down. He (Mr. Buchanan) said to him, "I use quite common scrap, mostly scrap from the wasters and yard, and I get my tests all right." Now that was a case where, although the metal was what they would term chemically impure, it gave good results, which a metal chemically pure failed to give. So he thought it would be found that fineness of structure would give results which a purer and dearer metal would not give when it came to testing.

Grey Iron with 0.28 per Cent. Silicon.

As regards the proportions of silicon and carbon in a given time, Mr. Cook could tell them more than he could as to the relationship between the silicon and the carbon contents in a given iron. In considering silicon and its influence on iron a great many things came into play which a few years ago, when they thought they knew more about it, did not appeal to them; in fact, it was not known that they existed. Mr. Shaw had an example of a grey iron with 0.28 per cent. silicon—a grey iron, grey in the pig and grey in the casting. He did not think there had been any explanation as to how such a low silicon content could exist and persist in a grey iron.

That brought him to the point that blast furnace conditions had an enormous influence outside the chemical composition. What those influences were, whether good or otherwise, they hardly knew as yet, but that they did exist was undoubted.

He quite agreed with Dr. Longmuir as regards the over-emphasis which had been put on the influence of sulphur. Ten or twelve years ago Mr. Coe gave them a Paper in Cardiff, in which there were laboratory experiments which bore out what they were wakening up now to realise was the fact, that the influence of sulphur and its good or evil result had been much exaggerated. It was so undoubtedly when the sulphur was high, but with the proper casting temperature it could be largely eliminated. One useful effect, especially in iron of close structure, was that it gave the necessary combined carbon if wanted.

Shock Testing.

The author referred to cast iron under shock. So far as he was concerned, he did not know anything about the results of shock as applied to cast iron. They did find results when fracture took place, but as regards any scientific readings as to the effect of shock on cast iron they might exist, but he was not aware of them.

His experience was that there was more carbonisation of the metal in the cupola than decarbonisation. In judging the defects of castings he should say carbonisation accounted for nine out of ten failures; where what was called dirt was concerned he should say they would find free graphite nine times for every one where they found silicon. If there was one mistake which foundrymen made more than another it was overcharging their cupolas with coke. They had an idea that large quantities of coke meant high temperature. They were not scientific enough to know that the combustion in the cupola was a chemical change, and by adding coke without regard to the amount of oxygen required to burn that coke they were depreciating their iron without getting the heat.

Total Carbon and Silicon Ratio.

MR. F. J. COOK said for many years past he had insisted on the importance of the relation between the quantity of total carbon and the quantity of silicon; he therefore gladly accepted the suggestion in this paper that the way to judge the quality of iron was more on those particular lines than on the lines adopted at the present time. If something could arise out of the Paper which would put the grading of pig-iron more on a basis of that description they would get nearer to regularity of working than they did now. In connection with judging the quality of cast iron on the chemical analysis, one point had been largely dealt with by Mr. Rhead; that was that there was something in the inherent qualities of iron other than was demonstrated by analysis. Mr. Rhead put his finger upon the point, with regard to the quality or the class of the carbon present. He should

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watch with a great amount of interest for the publication of the facts that Mr. Rhead had in hand.

Structure of Cast Iron Important.

The other point, which Mr. Buchanan referred to—the question of structure—was shown very clearly, he thought, many years ago in a paper written by the late Mr. Hailstone and himself. Very often structure was a surer guide than actual chemical analysis. They showed there that a similar analysis gave very widely different physical results which corresponded more to the structure or type of phosphide eutectic than to the actual chemical analysis.

With regard to the question of shock Mr. Buchanan would find something which might be of interest in the paper referred to.

Sulphur and Silicon.

In referring to the effect of sulphur in comparison with silicon Mr. Rhead stated that sulphur was 10 to 19 times more effective than silicon. He could not go to the highest figure, but it was on record in the Institute proceedings that they called attention to the fact that sulphur was ten times more effective, bearing out exactly what Mr. Rhead said. This question of the relation between the quantity of one element and that of another being of very great importance that figure of 10, with regard to silicon and sulphur, had predominated in his mind to a very large extent. In Mr. Coe's paper referred to by Mr. Buchanan, the question of the figure 10 came up remarkably. It was not mentioned by the author but it was shown that where sulphur was one-tenth of the silicon present they had it in the form which would give the highest physical properties. That figure 10 he had watched for a very long time. In grey iron 0.1 per cent. sulphur in comparison with silicon seemed in his mind to correspond with a good many experiences he had had.

He gladly welcomed this paper, and hoped that it would be the means of bringing about a better standard of judging irons than they had at present.

Semi-Steel Making.

MR. H. M. LANE said in the United States there were two methods of introducing steel in the melt. One consisted of using steel rails which contained more than 0.5 per cent. carbon and the other plate clippings. The steel rails, of course, were in fairly massive pieces, and melted with the iron perfectly on account of the relatively higher carbon content, and lower melting point, while the plate scrap, containing round about 0.20 to 0.25 per cent., carbon being of thinner sections sometimes passed the melting zone of the cupola and became burnt and entered the iron, giving a bad effect in that way.

A good many years ago he ran a series of tests in which they melted several tons of nothing but steel rails over and over again for casting test bars. They cast them to see the rate at which it affected the carbon. His recollection was that it was three melts before they reached a constant carbon content.

A Liner Trouble.

MR. S. G. SMITH said a few years ago he had an experience with a liner 2½ to 3 in. across and about 7 or 8 ft. long. It was machined and ground. Inside the liner all over there were little specks of what he took to be carbon which he could get out with the point of a needle. That came back to his mind when Mr. Rhead mentioned the rate at which some of this carbon was dissolved: and he would like to know whether Mr. Rhead thought those specks were due to carbon that had been dissolved in the melting of the iron. If it was not, was there any other explanation of that appearance? He had not come across any similar case. It had no relation to the ordinary graphite or ordinary carbon, which came from the machining. It was quite unique.

MR. RHEAD said before he answered the question which Mr. Smith asked he would like to have more particulars regarding the case in point, but he would mention another case which happened some years ago in connection with another liner. The casting did not show a series of specks, but a row of patches of a very marked type, half the size of his hand. They were arranged in order one above the other. The casting was cast on end. The question arose, what was the cause of those patches? Judging from the position, and from the general reading of the facts, he came to the conclusion that it was graphite which had been carried over in the kish, and in rising up the side of the mould it had lodged in various positions. The surface of the liner was machined and scraped, and they took a sulphur print which showed plainly that there was a very large amount of sulphide in those patches. They came to the conclusion that it was kish which had been carried over. The sulphide had risen to the surface and had produced the appearance in that way. Judging from that he would suggest that in the case Mr. Smith had mentioned it had been produced by actual deposit and not by undissolved graphite.

Carbon and Silicon.

Mr. E. Adamson, of Sheffield, wrote:—

Professor Siegle is to be congratulated on the manner in which he tackles the difficult and complicated problems of carbon in foundry irons and castings. He frankly admits the necessity of controlling carbon, and as frankly admits the practical difficulties of so doing. It is only by approaching this subject with frank admissions of the difficulties and the impossibility of controlling them by formulæ that there will be any hope of final success.

One of the most important points in the Paper is on the first page, where he recognises that the percentage of T.C. and Si in pig-iron is dependent upon the temperature of the blast furnace, and it is shown on page 4 that he realises if the blast furnace is working extra hot that it produces a ferro-silicon grade of pig iron, which is an abnormal fracture for foundry iron.

In the Paper it is stated that iron from the blast furnace rarely contains less than 2.00 per cent. or more than 4.50 per cent. T.C., but as the Paper is presumably given for the instruction of foundrymen in regard to ordinary grey foundry pig-irons, would it not be better to confine the limits to an actual minimum of, say, 3.00 per cent. T.C. and a maximum of, say, 4.00 per cent.? This would save any risk of possible demands for a low T.C. which the ironmaster could not possibly meet, for a virgin blast-furnace foundry iron with, say, 1.00 to 4.00 per cent. Si has probably never been made with a T.C. as low as 2.00 per cent. The 2.00 per cent. T.C. to which M. Siegle refers was *synthetically produced and was not a blast-furnace product.*

In Fig. 2 M. Siegle suggests diagramatically that if "M" fracture is obtained with a given percentage of T.C. and Si, that "M," being higher in both T.C. and Si than "O" and "N," the fracture would consequently be greyer than these. Unfortunately, however, "N" being lower in Si would probably have a higher T.C. than "M" or "O," and by reason of this fact would be higher in graphite and therefore greyer than "O." In any case "N" would be greyer than "O" by reason of higher T.C.; this is my *general* experience.

In 1908 Hersey, at Montreal, put forward a carbon-silicon balance formula of (T.C. × 3½) + Si = 15 to 16 per cent. Many pig-irons give 10.80 to 17.87 per cent., and in my experience there is no such formula which can be regularly applied because, as M. Siegle wisely states in the opening of his Paper, T.C. and Si depend on temperature of smelting.

The difficulties of attempting to grade and use pig-iron based on a carbon-silicon balance is clearly shown in Table I published in my Paper before the Iron and Steel Institute in 1911: all with the exception of one item, were from the same furnaces and all are hematites. This is also shown in one of Johnson's tables published in 1898, both of which are diagramatically illustrated in Figs. 1 and 2.

Irons of widely different total carbons present the same appearance of fracture, i.e., similar sizes of graphite flakes, and if it were possible to

take the temperature of the furnace at the time these grades were produced, it would probably be found that the temperature of the furnace itself decided the fracture rather than the ratio of Si to T.C. This is my considered opinion, although naturally the Si would have its *contributory* influence.

It is most interesting to read M. Siegle's reference on the solubility of graphite in boiling acids, which would appear to confirm Moissan, and his conclusions are quite correct that this aspect is of great practical importance, in fact of much greater importance than has so far been realised.

Further, in connection with the carbon and silicons in pig-irons, it is quite true that *in a very general way*, particularly if ferro-silicon grades of pig-iron are included, silicon displaces carbon; but there are also conditions graphically illustrated in Figs. 4 and 5 where *generally the T.C. increases with an increase of Si.* It is rather remarkable that not long ago I should have made this statement from information in my possession, which, being confidential, could not be published. The statement at that time was ridiculed, but M. Siegle's Figs. 4 and 5 have given the necessary practical proof.

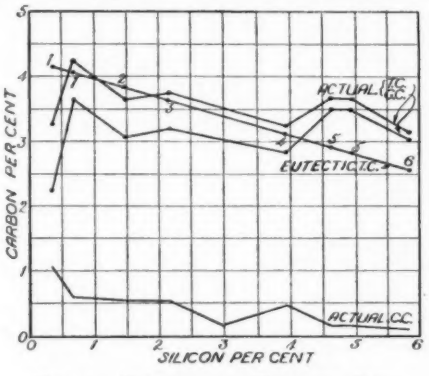

FIG. 1.—DIAGRAM FOR HEMATITE IRON CONSTRUCTED FROM MR. E. ADAMSON'S PAPER (I. & S. INST., 1911, TABLE I., PAGE 88).

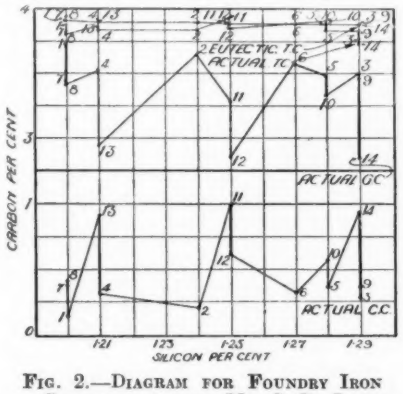

FIG. 2.—DIAGRAM FOR FOUNDRY IRON CONSTRUCTED FROM MR. G. R. JOHNSON'S PAPER (I. & S. INST., 1898, TABLE I., PAGE 210).

Figs. 4 and 5 also show how impossible it is to control T.C. in the blast furnace, especially if the Si is also considered, as these two tables prove that T.C. does not always decrease with an increase of Si and vice versa.

From these it will also be seen that the question of suitable grading of pig iron will not be settled by users alone or even by blast-furnacemen with experience in only one class of iron, as conditions of manufacture vary slightly in each iron-making district, and hence certain results which hold in some cases cannot be applied universally.

It is quite true, as M. Siegle points out, that the dearest irons are those which carry the maximum Si and the minimum S; but it is very pleasing to note that on the following page he states that S alone is not of great importance, with which I heartily agree. Were this latter statement more generally accepted within reasonable limits, it would make the question of the grading of pig-iron very much easier to solve, and would further go a long way towards eliminating the necessity for grading pig-iron by T.C. and Si contents. As a matter of fact, the general use of steel in the cupola practically counter-balances any difficulties with regard to high T.C., outside of freaks, because even if the theoretical T.C. charged on the cupola is 2.50 per cent., it is very rarely that less than 3.00 per cent. will be found in the casting, and if, with very high T.C., a percentage of steel scrap be added to give a theoretical T.C. on the cupola charge of 3.00 per cent., then no further carbon would be picked up in the re-melt, and M. Siegle is very wise in emphasising the difficulties of controlling the T.C. in foundry mixtures, unless it be by the appearance of the fracture.

Difficulties of Analysing Cast Iron.

Mr. H. J. Young wrote:—

Apparently M. Siegle seeks to illustrate, in Fig. 2, that whilst the percentage of combined carbon in grey iron of any one section and mass depends largely upon the amount of silicon present, that of the graphitic carbon depends also upon the amount of carbon present. By these means does he demonstrate the importance of total carbon.

M. Siegle says that "Chemical analysis is coming more and more into favour," aptly summing up the situation in the concluding paragraph of his Paper. The doctrine is perfectly correct, but there is one warning to be given, namely, it is very difficult to obtain accurate samples and analyses of cast iron, and it is no uncommon thing to find people relying upon analyses incorrect to the extent of being utterly misleading. With a large mass of really accurate analyses taken over a long period one obtains, and gets familiar with, data of an irrefutable nature which, combined with physical tests and practical results, "has an important bearing upon the interpretation of such factors as fluidity, shrinkage, etc."

Later, M. Siegle states, in no uncertain language, that so-called semi-steel has the same physical properties as ordinary cast iron *of similar composition*, further remarking that the material "simply has the properties which would be expected from the analysis." The writer (Mr. Young) has long sought after reliable evidence on the above points, and admits that thus far he has been unable to *prove* that semi-steel has any other, or any better, properties than those of a cast iron *of similar composition.* At the same time it is to be remembered that it is not easy to obtain two specimens alike in all six variables, one specimen containing 20 per cent. steel and the other none. From M. Siegle's statement it would appear likely that, for many commercial purposes, semi-steel is not to be distinguished from grey iron *of similar composition.* As to whether the two materials are actually identical is a neat point, which will not be solved until investigators make a rule of comparing irons of identical composition, or with only one varying factor.

It is really astonishing to note the number of papers on cast iron, dealing with the effect of one particular impurity or process, where the investigators have chosen to work upon samples or under conditions where half-a-dozen things are varying at once. As an example, a German investigator, in a recent paper *on the effects caused by combined carbon varying from* 0.3 *to* 0.6 *per cent.*, chooses, for his examples, three cast irons in which are the following variations: Total carbon, 3.25 to 3.51 per cent.; graphite, 2.41 to 2.99 per cent.; silicon, 1.11 to 2.79 per cent.; phosphorus, 0.40 to 1.15 per cent.; sulphur, 0.08 to 0.15 per cent.; and manganese, 0.56 to 0.79 per cent.

If M. Siegle will do some careful and extensive work upon ordinary cast irons for ordinary purposes, containing between 0.06 and 0.15 per cent. sulphur, he will find, providing the sulphur is kept balanced by manganese, that the "extremely harmful influence of sulphur" is a myth. He (Mr. Young) desires to thank M. Siegle for his excellent Paper, which is a perfectly straightforward statement of things as M. Siegle has found them to be, together with a distinct challenge to the theories of the fracture school and also to those of some semi-steel enthusiasts.

Correspondence.

Carbon in Cast Iron.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—In connection with the above subject there have been two Papers in THE FOUNDRY TRADE JOURNAL issues of June 7 and 14 respectively, which are of considerable interest to foundrymen. These are:—

(1) "Pearlite Cast Iron: Its Production, Mechanical Properties and Possibilities" (June 7).

(2) "Notes on Carbon in Foundry Irons and Castings," by M. Siegle; this latter Paper being read and discussed at the recent I.B.F. Conference at Manchester.

On reading the former article it is evident that the term "pearlitic" is applied to cast iron in which a maximum pearlite content has been obtained by a special process, which, at the same time, has produced a fine form of graphitic carbon. The assumption, however, appears to be that the improved mechanical properties are due to obtaining this high pearlite content, or, to put it in less technical language, to the combined carbon being as near to 0.89 per cent. as possible. In the first few lines of the article we find the statement, "Ferrite is the softest constituent of the iron-carbon alloys, and the graphite does little to diminish the already low mechanical strength of the material." Foundrymen cannot, I think, agree with this statement as regards the influence of graphite. Coming to the analyses and tests of the three different grades (Table I.), the results as regards strength, etc., are precisely what we should expect, assuming normal casting temperatures. The composition of the pearlite iron approximates quite closely to that used in this country for grey iron castings where maximum strength is required. It is entirely erroneous to assume, however, that a combined carbon content of 0.80 to 0.89 per cent. is of necessity associated with strength, even if phosphorus is also low. To give a concrete example, one of the lowest tensile strengths I have obtained was given by a test bar containing 0.80 per cent. combined carbon. It was obtained by melting in the crucible a low-silicon (1.0 per cent.), low phosphorus (0.20 per cent.) iron, which showed a dark and very granular fracture. The test bars were cast 1¾ in. dia. and turned to 0.798 in. dia. for testing. The tensile strength was under 8.0 tons per sq. inch. Carbon estimations on the test bar showed:—Total carbon, 4.20; graphite carbon, 3.40; and combined carbon, 0.80 per cent.

Microscopic examination as well as fracture showed the low strength to be due to coarse graphite. Combined carbon must be considered in relation to the amount of graphite present, and not as in itself determining strength. The importance of low total carbon for strong cast iron has been very persistently advocated for many years by many of our leading foundrymen. The figure that seems to have emerged as a desirable maximum is 3.25 per cent., which, by the way, is the percentage present in "pearlitic cast iron." The first essential for strength is fine graphite, and low total carbon is generally associated with this requirement. Whatever the variations in other constituents have been, I have generally obtained best physical results when this figure for total carbon has been adhered to as closely as possible.

M. Siegle's Paper gives a very clear statement of the present state of affairs in regard to the grading of pig-iron. His comments on the systematic examination by Professor Wüst of different consignments supplied to the same grade number are very interesting, particularly to the founder producing light-section castings, which must be soft for machining purposes. The open-fractured pig-iron desired for this purpose (under present fracture grading) may be associated with:—(1) Normal total carbon, and silicon in the correct range for this type of casting, say round about 2.5 per cent. This is what we are supposed to believe. (2) Abnormally high total carbon and quite low silicon, much too low for light castings.

Chemical analysis will not solve all foundry troubles, but in cases like the above it will prove of very great assistance.—Yours, etc.,

HILTON MILLS.

Stocks, Middleton, Manchester.

Pearlite Cast Iron.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—The Paper by Professor Bauer on the above subject, translated from Stahl und Eisen, reported in the JOURNAL on page 454, is a most interesting contribution to the subject of cast iron, but whether it will be of any practical value in the world of commerce—quite apart from the expensive heating of the moulds—is another matter, and it can be fairly accurately predicted that pearlitic cast iron will have no bearing whatever on the question of classification of pig-iron.

On page 492 Mr. Gresty rightly points out the difference in structure when the graphite varies, as it can do with the same percentage of total carbon, and with the further complication of the variation of other elements.

On the same page Mr. Young also states, which is perfectly true, there is no proof that the percentage of combined carbon indicates the final properties of the metal. Mr. Smalley has also stated the same thing in a recent Paper, so that on this point everybody is agreed that the critical percentage of combined carbon, otherwise pearlitic structure, does not control the physical properties of cast iron.

Mr. Young points out from the analyses given in Table I. it may be claimed that higher combined carbon, or lower silicon, or even the lower phosphorus, or a combination of these, might be claimed as giving the higher test, although Professor Bauer claims the pearlitic structure, which is really only another name for combined carbon, present in a definite percentage round about 0.89 per cent.

From a casual reading of Professor Bauer's article, one might be led to believe that pearlitic cast iron was patentable, but foundrymen can rest assured that the idea alone is not subject matter for a patent, as it is only the *method* by which the pearlitic structure is arrived at which might—not necessarily is—patentable, and if pearlitic cast iron can be obtained in any other way than that used by Diefenthaler and Sipp, then foundrymen can rest assured they are at liberty to produce it in whatever other way they may choose, and there are several ways in which it can be done.

There is, however, another obvious fact. The materials used to produce the pearlitic structure of "P" were different from those used for samples "G" and "Z." These two latter appear to have been made from a natural blast-furnace *grey foundry* iron product, but from the very meagre information given of the materials used, it would appear that to obtain pearlitic cast iron by the patented method it is necessary to use mottled or possibly even white pig-iron, which has to be melted along with carbon and silicon additions. To obtain homogenity with these materials they would probably have to be melted in a crucible or bath type of furnace, in order—to quote Professor Bauer—"to give as little stimulus as possible to the formation of graphite." It is so well known as to hardly need repeating here that the addition of high-grade ferro-silicon to white or mottled iron produces, and in close grey pig-irons retains, the graphite in its most finely divided state, and thus gives a much closer grained iron than if the same silicon contents were obtained from melting a higher silicon open pig-iron. The closing of the grain in itself would give a much higher test, and if the operation of melting were carried out in a crucible or an electric furnace, this again would probably give a higher test than if the melting were done in the cupola; hence, in the writer's opinion, there is nothing whatever in the claims of pearlitic cast iron except the method of obtaining it, and that this structure can be obtained in several ways, including that of so-called "semi-steel," which is fairly well known.

	42 m/m bar.		32 m/m bar.	
—	Kgs per sq. m/m.	Tons per sq. in.	Kgs. per sq. m/m.	Tons per sq. in.
"G" ..	13	8.25	16	10.16
"Z" ..	17	10.79	22	13.97
"P" ..	25	15.87	28	17.78

It is difficult to compare all the tests given, but it may be sufficient to give the English equivalents of the tensiles, which are as follows.

Two sizes of bar were used, 42 and 32 mm., and the tensiles from both these are given below:—

Foundrymen will readily agree that there is nothing remarkable in these tests, and that they are regularly being obtained in Great Britain, both from all pig-iron mixtures and also from semi-steel, hence there would appear to be nothing exceptional in the tests of "pearlitic" cast iron.

The Brinell hardness test also appears to be somewhat on the low side, and probably this is accounted for by the softening effect of the heated moulds.

The claim, therefore, in the second half of col. 2, page 454, of high tests does not appear to be anything very exceptional.

Claim 4 suggests a less tendency to piping in pearlitic cast iron, but this would require greater explanation and proof than the mere statement.

Claim 6, with regard to the fine dense structure being unaffected by temperature changes, also requires further elucidation before it can be accepted. Should Professor Bauer refer to the structure of the test bars of 42 and 32 mm. as being unaffected by casting temperature or by the temperature of the mould, this may be largely true in the use of ferro-silicon added to white pig-iron, but if it is suggested that the pearlitic structure is not affected by temperatures such as are customary in Diesel engines or gas-engine cylinders, liners, etc., then absolute proof would be required before this statement could be accepted, general experience being that the combined carbon is reduced under such conditions, hence also the areas of pearlite.

Fig. 6 on page 456 is scarcely a true comparative chart, because it gives a straight datum line for ordinary cast iron "G," and it would have a very different appearance if the datum line were taken at zero.

Foundrymen will probably now consider the four claims put forward at the end of the Paper on page 456 in the light of this criticism, whilst those who are engaged in Diesel-engine work know that mixtures are now being used which are superior to pearlitic cast iron; as a matter of fact, some years ago I investigated the broken part of a Diesel-engine casting which was probably made some eight years ago from a cupola mixture, and every micro of a large number taken showed the pearlitic structure.—Yours, etc.,

E. ADAMSON.

19, York Street, Sheffield.

A National Die-Casting Research Scheme.

The British Non-Ferrous Metals Research Association has undertaken an extensive series of investigations on die casting alloys which will spread over at least three years and entail an expenditure exceeding £10,000. Full particulars of the scheme can be obtained from the Association's headquarters, 71, Temple Row, Birmingham.

The development and support of die casting in this country as a means of rapid production is recognised as of great national importance both for ordinary commercial production in the most diverse industries, as also for munitions and equipment of the fighting services.

The Department of Scientific and Industrial Research, after holding conferences of those interested in die castings, has promised most substantial financial support to the research. The Research Associations of the British Motor and Allied Industries, of the Scientific Instruments, and of the Electrical and Allied Industries have also afforded their support, and are represented on the Committee controlling the investigations. It remains for the industry—makers and users—to provide their quota of the fund required, as without this it will be impossible fully to develop the work, the results of which will be primarily available to those who support the research.

Since die castings serve chiefly as components of plant and machinery, it is not always recognised how important they are, but anyone inquiring into the subject will come across very varied uses in the automobile industry, and such applications as brush gear of electrical machinery, gas meter parts, vacuum cleaner fittings, etc., etc.

Sooner or later almost every branch of industry in which metal parts of any complicated shape are required turns to die castings as the ideal for economical production. The sphere of application will extend considerably if the research work contemplated succeeds in improving the quality and assuring the reliability of the alloys used.

Various types of alloys are used in die casting, and, recognising the wide field, the proposed research has been divided into three sections:—(1) Brass and bronze alloys; (2) aluminium alloys; (3) low melting point alloys (zinc, tin, lead, etc.). These three branches, with suitable arrangements for co-operation, will be dealt with in separate institutions, under the supervision of recognised leaders of metallurgical research.

Every care is being taken in the constitution of the Committee which controls the work to ensure that both the manufacturers and the users are represented.

Work of this nature demands the close interest of the industry, and it is hoped that no difficulty will be experienced in obtaining the small subscriptions required to assure the substantial Government support, which is only available in a measure dependent on the backing of the scheme by the industry.

"Moulders" of the Industry.—No. 7.

Mr. E. H. Broughall.

Mr. E. H. Broughall, who was elected Junior Vice-President of the Institute of British Foundrymen at the Manchester Conference, has all his life been associated with Coventry. He was born there in 1870, and was educated locally at Bablake School and the Coventry Technical Institute. After serving a seven years' apprenticeship, Mr. Broughall some 23 years ago identified himself with Messrs. Alfred Herbert, Limited, the well-known machine tool makers of Coventry, and for the last 17 years has been manager of their Edgewick works and foundries. He has always taken

MR. E. H. BROUGHALL.

a live interest in technical societies, joining both the Institute of British Foundrymen and the Coventry Engineering Society at their foundation. Of the latter Mr. Broughall is now vice-president. Before the Staffordshire Iron and Steel Institute and other societies he has read several papers dealing with the effect and use of denseners and the commercial and technical aspect of permanent moulds. Mr. Broughall is also a member of the Institution of Mechanical Engineers and the American Foundrymen's Association.

International Foundry Exhibition and Congress, Paris, 1923.

Itinerary.

TUESDAY, SEPTEMBER 11.—2 p.m., leave London (Victoria Station, S.E. & C. Sec.) *via* Dover and Calais; 9.40 p.m., arrive Paris (Nord Station). (Dinner will be served *en route* between Calais and Paris.)

WEDNESDAY, SEPTEMBER 12.—9 a.m., registration of visitors, distribution of badges, and reception at the Ecole des Arts et Metiers, Boulevard de l'Hôpital; 10 a.m. to midday, opening ceremony by the Under-Secretary for Technical Education, followed by a Technical Session; 3 p.m. to 6 p.m., visit to the Exhibition and the School Foundries and Workshops; evening free.

THURSDAY, SEPTEMBER 13.—9 a.m., Technical Session in English; 2.30 p.m. to 6 p.m., visit to foundries, see English Section of the Souvenir Programme; evening free.

FRIDAY, SEPTEMBER 14.—9 a.m., French Session; 1 p.m., luncheon at the Eiffel Tower, visit to the Tower Machinery; 3 p.m. to 6 p.m., visit to the Paris foundries, see English Section of the Souvenir Programme; evening free.

SATURDAY, SEPTEMBER 15.—9 a.m., final Technical Session; 1 p.m., meet at the pleasure boat *Le Touriste* on which luncheon will be served, excursion to St. Gervais, visit to the Forest and Castle; 5.30 p.m., return to Paris; 7.30 p.m., banquet, see Souvenir Programme.

SUNDAY, SEPTEMBER 16.—8.30 a.m., leave Paris (Nord Station) *via* Boulogne and Dover; 3.45 p.m., arrive Victoria Station (S.E. & C. Sec.). (Luncheon will be served between Paris and Boulogne, or on the steamer.)

The inclusive fare for the above is £10 7s. 6d. each passenger, and provides for (1) second-class travel tickets, with saloon on steamer, from London to Paris and back; (2) hotel accommodation, consisting of bed and English breakfast in Paris, commencing with bed on Tuesday, September 11, and terminating with breakfast on Sunday, September 16; also dinner *en route* to Paris on the outward journey, and luncheon on the homeward journey; (3) excursion on September 15 by pleasure boat to St. Gervais and luncheon; (4) banquet on the evening of September 15, including wine; (5) transfers between station and hotel on arrival in and departure from Paris; (6) all fees and gratuities to hotel and railway servants, and to the drivers of conveyances utilised; (7) free conveyance of 66 lbs. of baggage from London back to London; (8) services of a competent courier throughout, who will act as interpreter whenever necessary.

General Notes.

LUNCHEONS AND DINNERS.—These meals during the stay in Paris are not included in the fare quoted, except where special arrangements have been made as specified in the programme.

HOTEL ACCOMMODATION.—The fare of £10 7s. 6d. provides for accommodation at the Hotel Moderne, Montreal, Louvois, or Bedford, or similar grade of establishment. Delegates wishing to be accommodated at the Hotel Lutetia, Hotel du Palais d'Orsay, or similar establishment, the inclusive fare will be £11 12s. 6d. each person.

ALTERATION OF FARES, ETC.—The fares quoted are liable to alteration without notice. The train and steamer services are also subject to modification.

PASSPORTS.—Delegates travelling to Paris must be in possession of a valid passport. Application forms for passport, and any further information desired on this subject, can be obtained from Mr. A. S. Beech, 97, Queen Victoria Street, London, E.C. Passports must be obtained before tickets will be issued by Messrs. Thos. Cook & Son.

INSURANCE.—Travellers are strongly advised to avail themselves of Messrs. Thos. Cook & Son's system of baggage insurance. Life and accident insurances effected for long or short voyages or journeys. Proposal forms and full particulars on application.

CARRYING FUNDS.—It is suggested that delegates carry their funds in the form of travellers' cheques (circular notes) issued by Thos. Cook & Son, for sums of £20 and upwards, in notes of £5, £10, or £20 each. This is the safest, most convenient, and best form in which to carry money. Letters of credit are also issued, and foreign money supplied and exchanged.

BAGGAGE.—The most convenient form of baggage is small portmanteau or suit cases which can be taken into the railway carriages.

RETURN.—Tickets issued in connection with the special party to Paris will be available for 15 days from the date of departure from London and by any service from the Nord Station (with the exception of the 12 noon train which is due to arrive at Victoria at 8.25 p.m.). Individual travellers returning from Paris after Sunday, September 16, will have to pay for luncheon *en route* between Paris and London. If, however, a number should travel together, and Messrs. Thos. Cook & Son are advised in advance, they could order any meals desired.

Foundrymen who are not members of the Institute of British Foundrymen should apply to the General Secretary, 38, Victoria Street, for information as to conditions of membership.

Post Convention Tour No. 1.

Arrangements are being made for a party, which will include members of the American and British Institutions, to visit points of interest in Eastern France and Belgium, after the Paris Conference. The tentative programme for this journey will be as follows:—

Sunday and Monday, September 16 and 17.—In Paris.

Tuesday, September 18.—Leave Paris by evening train for Nancy. (Grand Hotel or similar establishment.)

Wednesday, September 19.—Plant visitation, Nancy district.

Thursday, September 20.—Leave Nancy by motor car, *via* Pont à Mousson, St. Mihiel and Verdun, to Metz. (Hotel Angleterre or similar establishment.)

Friday, September 21.—Proceed by rail from Metz to Liège. (Hotel Suede or similar establishment.)

Saturday, September 22.—Plant visitation at Liège. In the evening, reception by Belgian Foundrymen's Association.

Sunday, September 23.—Proceed by rail from Liège to Brussels. Three hours' drive in Brussels. (Hotel Metropole or similar establishment.)

Monday, September 24.—Leave Brussels for Lille. International Harvester Company plant visitation at Lille. (Hotel de l'Europe or similar establishment.)

Tuesday, September 25.—Proceed by rail from Lille to Paris.

The inclusive fare for this extension tour is £18 each passenger, staying at the Hotel Moderne, Louvois, Bedford, or similar establishment in Paris, but is subject to alteration. For delegates staying at the Hotel Lutetia or Hotel du Palais d'Orsay the inclusive fare will be £18 10s.

The fare provides (1) second-class travel tickets from Paris back to Paris; (2) accommodation at the hotels specified, or similar establishments, consisting of bed and English breakfast, commencing with bed on September 16 until breakfast on September 25; also the following meals *en route* will be supplied:—Tuesday, September 18, dinner; Thursday, September 20, luncheon; Friday, September 21, luncheon; (3) transfer of passengers and baggage from station to hotel and *vice versa*, wherever necessary; (4) drive by private motor car from Nancy to Metz, and afternoon drive by autocar in Brussels; (5) expenses of sight-seeing and admission fees to all places of interest visited by the courier; (6) all fees and gratuities to hotel and railway servants, and to the drivers of conveyances utilised; (7) free conveyance of 66 lbs. of baggage; (8) services of courier from Paris back to Paris, who will act as interpreter whenever necessary.

Post Convention Tour No. 2.

Arrangements have been made for a limited number of delegates to visit the Le Creusot Works of Messrs. Schneider et Cie. The itinerary is as follows:—

Monday, September 17.—Leave Paris Gare de Lyons 3.15 p.m.; arrive Le Creusot 10.53 p.m.

Tuesday, September 18.—Morning visit to the works: lunch at Le Petite Verrerie, by kind invitation of Mons. Schneider. Afternoon visit to the works. 8.28 p.m., leave Le Creusot; arrive Paris 5.10 a.m.

Book Reviews.

L'ECLAIRAGE SOLUTIONS MODERNES DES PROBLEMES D'ECLAIRAGE INDUSTRIEL. By E. Darmois, of Nancy University College. Published by Messrs. Gauthier-Villars et Cie., 55, Quai des Grands Augustins, Paris VI. Price 15 francs.

The title of this work, translated literally, is Lighting: Modern Solutions of Problems of Industrial Lighting. The book contains 280 pages, is well illustrated by numerous diagrams, and is bound in stiff paper.

The first chapter deals with definitions and lighting units, and a fair amount of mathematics are introduced. In the second chapter, dealing with photometry, the subject is treated very thoroughly from a mathematical point of view. These two chapters constitute Part I., and only those having a knowledge of advanced mathematics can follow it.

The second part is not free from mathematics, but the treatment is of a much simpler character. Amongst subjects treated of interest to foundrymen and metallurgists are found the following:—Incadescent lamps; arc lamps; gas lighting; the human eye; colour considerations; refectors and natural lighting.

Finally, the questions of factory, yard and domestic lighting is dealt with, always basing conclusions on mathematical and physical constants. Undoubtedly, to obtain a maximum benefit from this book the reader must possess a fair knowledge of these subjects. The book shows most clearly that there is a definite scope in industrial engineering for the "specialist lighting engineer."

LES ECONOMIES DE COMBUSTIBLES: CONDUITE RATIONNELLE DES FOYERS. By Pierre Appel. Published by Messrs. Gauthier-Villars et Cie., 55, Quai des Grands Augustins, Paris VI. Price 17 francs.

This book, which is uniform with the one reviewed above, has a title which admits of the rough translation of Fuel Economy and Furnace Operation. The purpose of the book is to show that all industrial heating installations are capable of modification to give important economies, and to point out the methods to be followed to gain this desirable end. To do this the author considers it unnecessary to describe the various types of boiler furnaces or gas producers, but confines himself to a consideration of the ascertainment of the actual thermal efficiency of any unit, and describes in detail the various apparati necessary to accomplish this. It is the type of book which, on translation, could be very usefully used in technical schools as a text-book to be studied by those taking lectures on fuel. It is a book we can recommend to those metallurgists and foundrymen who undertake from time to time the checking of the efficiency of heating and melting units.

WORKSHOP ROUTINE.—By W. J. Hiscox. Published by Messrs. Chapman & Hall, Limited, of 11, Henrietta Street, London, W.C.2. Price 9s. 6d.

This book forms one of the publishers' directly useful technical series, and we have no disagreement with the implification, as undoubtedly it is full of useful suggestions.

The chief feature of the book is the insistence of "Standing Instructions," a series of which when handed to a new member of the staff would explain the whole system in vogue at the works. The question arises as to whether such matters can be overdone. To be clear, they should be very plainly and simply worded, but in some cases owing to their great importance they need to be legally drawn up. Herein lies a paradox, which makes a manager hesitate whether to give verbal or loosely worded instructions, or, carefully constructed documents on the interpretation of which he must either swim or sink. If such vast importance to "Standing Instructions," they should certainly be signed by a "man whose author cannot be challenged."

It is pleasing to note that the foundry is well considered throughout the book, which makes it equally interesting for the maker and buyer of castings. Mr. Hiscox is well known to our readers, having been a regular contributor of articles dealing with organising and costing for some years. It is rather an inspiring book, and could usefully be included in any foundryman's book shelf.

Foundry Queries.

Cupola Troubles.

In using a cupola receiver, trouble is experienced in mending the connection due to heat retained after a blow, and difficulty of access. It is proposed to make the receiver top loose and lift it off when required by suitable tackle. The sulphur pipe is not connected to the cupola and so presents no difficulty. It is proposed, also, to reline the cupola near the charging door with cast-iron hollow bricks instead of usual fire bricks, lining the lower part, including the melting zone, with a well-advertised ganister material.

The experience of your readers would be appreciated.—"S. C. B." (Leeds).

Patent Specifications Accepted.

Particulars of Complete Specifications accepted, furnished by MR. ERIC POTTER, *Patent Agent, of 27, Chancery Lane, London, W.C.2.*

Printed copies of the specification in the following list will be on sale on July 12, 1923.

Archer, R. S., and Jeffries, Z.—Heat treatment of castings of aluminium alloys.

Myers, H. A.—Casting of metals.

Bower, A. S.—Casting or Moulding metals and the like.

Harding, R. C.—Charging blast furnaces.

Obituary.

MR. J. HOGG, a director of James Hogg & Company (North Shields), Limited, brassfounders, died recently in his 72nd year.

MR. T. BORROW, of Newham Grange, a member of the firm of Messrs. T. S. Borrow & Company, steel merchants, of Stockton, died last week.

MR. A. STUART ELSWORTH, a director of John Elsworth & Sons, Limited, tool manufacturers, etc., of 211, Bothwell Street, Glasgow, and Malinda Street, Sheffield, died on June 18.

MR. J. B. SUMMERSCALES died at his residence, Rockfield, Keighley, on Saturday last, at the age of 62. He was senior partner in the firm of W. & S. Summerscales & Sons, Parkside Works, Keighley.

MR. JOHN ANNAN BRYCE, formerly Liberal member for the Inverness Burghs, has died at his residence in Brvanston Square, London, W., at the advanced age of 79 years.

Personal.

MR. G. C. VYLE, managing director of W. & L. Avery, Limited, Soho Foundry, Smethwick, has been appointed a member of the Birmingham and Sutton Coldfield War Pensions Committee.

MR. A. J. FORSDIKE, of Sheffield, has been elected a director of Wm. Cooke & Company, Limited, to fill the vacancy caused by the death of Mr. Ambrose Firth. Mr. James Thornhill and Mr. Leonard H. Else have been elected official directors.

Wills.

CRAVEN, J. W., chairman and managing director of Bradley & Craven, Limited, Wakefield	£20,438

Iron and Steel Institute.

Sir William H. Ellis, G.B.E., D.Eng., managing director of John Brown & Company, Limited, has been nominated by the Council of the Iron and Steel Institute for election as president of the Institute next year. He will assume office at the May meeting of the Institute in 1924, in succession to Mr. Francis Samuelson, of Thirsk, who has been president since 1922.

MR. H. WINCOTT, managing director of G. P. Wincott, Limited, engineers and furnace builders, Sheffield, who has just returned from a business tour in Italy, has obtained orders for the reconstruction of the open-hearth steel melting furnaces, soaking pits, sheet mill and annealing furnaces from La Magona d'Italia.

XUM

IRON AND STEEL MARKETS.

Pig-iron.

MIDDLESBROUGH.—The position of the Cleveland iron market remains weak, and movements during the past week have been restricted almost to the point of stagnation, demand now being practically reduced to retail proportions. Prices, meanwhile, though weakening slightly, continue at too high levels to stimulate buying to any extent, Cleveland iron being still dearer than either Scottish or Midland makes, and until quotations can be reduced to practicable levels it is apparently hopeless to expect improvement in business. Fuel costs, for some time past, are the chief obstacles to the realisation of cheap pig-iron, but, unfortunately, with the continued export demand for coke at inflated values, it seems unlikely that any relief in this direction is immediately possible. To add to the existing difficulties of the situation on Tees-side, it is significant that a certain amount of cheap Belgian foundry iron is again coming into the Tees. The French, too, are exporting foundry iron to America. Meanwhile, there is a slow but progressive weakness in values. On 'Change last week makers were quoting No. 3 G.M.B. at 115s., but this week lower figures were taken, 110s. being actually reported. Moreover, makers would, no doubt, accept a still lower figure for a substantial contract. Similarly, No. 4 foundry is weak at 105s, and No. 4 forge 102s. 6d. per ton. No. 1, though still on the scarce side, is easier at round about 120s. to 125s. per ton.

The hematite market is very quiet. A fair business is still passing for home steelworks' requirements, but export trade is very stagnant, and current outlets are quite inadequate to absorb the heavy production. Hence prices continue to break, and this week 111s. to 112s. has been done for E.C. mixed numbers. But this figure, too, could be further shaded against substantial business. A premium of 6d. per ton is asked for No. 1 quality. For West Coast hematite the buying still being done by Continental and home users is almost entirely of a hand-to-mouth character. Prices have, however, undergone no further depreciation, Bessemer mixed numbers being quoted at £6 2s. 6d. to £6 5s. per ton delivered at Glasgow and Sheffield and for export, while the quotation for low phosphorus iron, which is in fairly steady demand, is also unchanged.

MANCHESTER.—Business in the local pig-iron market remains in a depressed condition, and though values show a further downward tendency, the movement is not sufficiently pronounced to attract buyers of foundry qualitites to any marked extent. It is apparently useless to tempt consumers by offering a shilling or so in the way of concession when they claim that pig-iron ought to be 20s. cheaper. Hence makers of pig-iron in the Midlands do not offer any reduction, but it is fairly well understood that if an order is ready to be placed it can be arranged at from 2s. 6d. to 3s. per ton below the nominal prices. In this district large consumers of foundry iron are doing practically nothing. Roughly speaking, pig-iron is from 5s. to 7s. 6d. per ton cheaper than it was at the end of April, but the fall has had no effect at all in the way of inducing ironfounders to add to their stocks.

THE MIDLANDS.—In the South Staffordshire area the demand for foundry pig may be described as quiet but fairly steady, with quotations so far unchanged, though it is quite understood that smelters can be induced to make concessions on inquiries on any substantial scale. Pending the forthcoming quarterly meeting of the trade, it is difficult to frame a representative list of quotations for Midland furnaces, but the following may be accepted as the rates now ruling for foundry qualities:—Northamptonshire No. 3, 102s. 6d.; Derbyshire No. 3, 102s. 6d., all f.o.t. furnaces. Baldwins, Limited, Netherton Furnaces, are also quoting their No. 3 foundry at 110s., No. 1 foundry at 115s., and common Staffs at 107s. 6d., all delivered equal Birmingham district.

SCOTLAND.—The near approach of the Glasgow Fair holidays, and the general stagnation in local industries, have combined to further curtail business in the Clydeside iron market, and business is quiet in the extreme. The engineering founders are exceedingly quiet, and in some cases have no orders whatever on their books. It was hoped that the Falkirk founders would be buying a little more freely to fill their needs after stocktaking and holidays, but whilst some inquiries have come into the market, the tonnage is disappointing. No. 3 Middlesbrough is quoted here at £5 17s. 6d. f.o.t. Grahamston, whilst No. 3 Continental is £5 10s.

Finished Iron.

The half-yearly stocktaking and the usual summer holiday season are having a restricting influence on most branches of trade in finished material, and only a very limited extent of business is passing, either for home or export. Unfortunately, the outlook for the remainder of the year is scarcely hopeful, and manufacturers generally experience considerable difficulty in obtaining new orders to replace contracts in course of completion or already delivered. Makers of commoner qualities of bars in South Staffordshire are having a very quiet time, owing partly to foreign competition at prices which they cannot touch. The bulk of the business in this class of iron seems to be going abroad. Nominally the quotation is unaltered, but £11 is mostly impossible. Conditions are moderate in the marked-bar trade, though demand is not so brisk as it was a few months ago. There is no change to record in connection with iron strip. Some who are amongst the largest makers nominally have shut down their mills entirely.

Steel.

The position in most branches of the steel industry remains without tangible improvement, and although some firms are comparatively active on old orders, new business is increasingly difficult to obtain. In the markets very contradictory reports are in circulation concerning "semis," among them the positive statement that some makers would accept much below £7 12s. 6d. for soft billets if contracts of any size were offered to them. Demand is very poor, however. Wherever the material can be suitably used consumers seem to have covered their requirements by purchases of Continental material, and they are not prepared to enter into further contracts of any size. Keen Belgian competition is again reported in the commoner classes of steel, and the conditions abroad appear to be a little brisker. Several bulk inquiries are about for ferro-silicon and ferro-manganese, while one or two nice inquiries for ferro-vanadium have also been circulated. In the tinplate market a moderate inquiry has only resulted in a small proportion of orders, in spite of the fact that several works are now quoting the official minimum selling price; buyers are not willing to commit themselves ahead, and seem to be holding off all they can. Quotations ruling for the standard sizes may be called :—Coke finish : IC 14 x 20, 112 sheets, 108 lbs., 23s. 1½d. to 23s. 3d. per box; IC 28 x 20, 56 sheets, 108 lbs., 23s. 7½d. to 24s. per box, with options as per schedule, net cash, f.o.b. Bristol Channel ports.

Scrap.

Conditions in the various markets for scrap metals are much the same as last reported, buying being now reduced to the barest limits of necessity, with stocks accumulating in dealers' yards. In Lancashire ironfounders are apparently determined to wait until pig-iron is down again to 80s. per ton before they buy any more than the small lots they need to keep their cupolas going, and hence, when good cast scrap is offered to them at that price per ton, or 30s. below the present cost of pig-iron, they are quite indifferent, and do not regard it as remarkably cheap. The fact is that a large number of the foundries are now short of work, and it is not known what prices will be available for castings when they get to work again. Consequently foundrymen are averse from buying for stock, and very little business can be done in cast scrap. The quotation is still about 80s. per ton, but it must be regarded as purely nominal. There is still a very poor demand in the Midlands for cast-iron scrap for use in the foundries. Generally speaking, the foundries are not so full up with work as they were a few months ago, and in view of the fall in pig-iron, prices have depreciated and are likely to decline still further, while consumers are not anxious to purchase ahead. They are, however, at the moment paying for small quantities 90s. to 92s. 6d. delivered to works for good quality broken machinery, and 67s. 6d. to 70s. for light, delivered to works.

Metals.

Copper.—The course of quotations in the market for standard metal of late has marked a lower tendency, the influential support ascribed to American interests having been withdrawn, with a consequent weakening of values. An improvement was reported in the

(*Continued on page* 22.)

MACNAB & Co.

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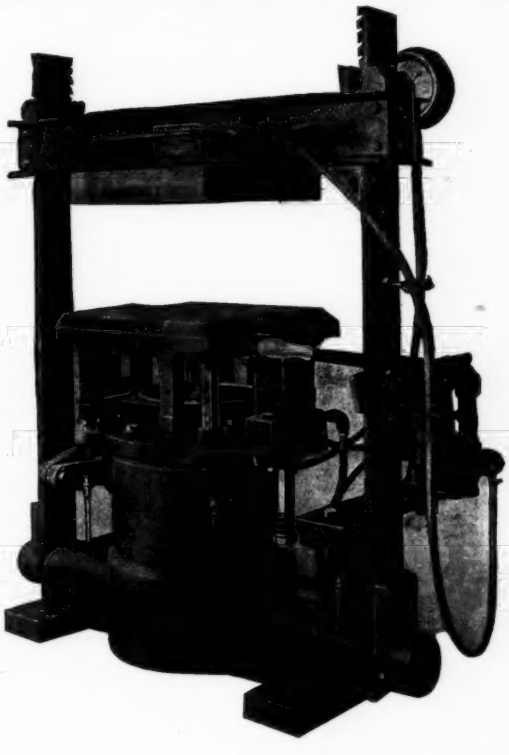

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Minimum Percentage of Wasters.

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IRON AND STEEL MARKETS—*continued.*

domestic demand in the States, but New York quotations for electrolytic have again been easier, and it would appear that the producing interests in that country have not now such a hold on the market. The demand from home consumers remains on a moderate scale, while the Continental inquiry shows some slight improvement. Manufacturers of copper sheets are experiencing a scarcity of orders, and seem disposed to reduce quotations a little. Current quotations :—*Cash* : Thursday, £64 7s. 6d. ; Friday, £64 17s. 6d. ; Monday, £64 12s. 6d. ; Tuesday, £64 17s. 6d. ; Wednesday, £64 15s. *Three Months*: Thursday, £64 17s. 6d. ; Friday, £65 7s. 6d. ; Monday, £65 2s. 6d. ; Tuesday, £65 7s. 6d. ; Wednesday, £65 5s.

Tin.—In common with other sections of the metal markets, values of standard tin have declined to some extent during the past week, and business on the whole has been quiet. Sales reported in the East of late have again been small, but on the other hand demand continues poor, and confidence is disturbed by the continued unsettlement in Europe and the prolonged abstention of buyers in the States. American inquiry on this side has been almost absent, and prospects of a revival in the general trade demand are not very promising. Under the decidedly weaker aspect thus outlined, consumers, although possibly allowing their reserve stocks to fall rather low, seem in no hurry to re-enter the market. Current quotations :—*Cash* : Thursday, £180 17s. 6d. ; Friday, £182 12s. 6d. ; Monday, £176 15s. ; Tuesday, £177 15s. ; Wednesday, £176 2s. 6d. *Three Months*: Thursday, £181 17s. 6d. ; Friday, £183 12s. 6d. ; Monday, £177 17s. 6d. ; Tuesday, £179 5s. ; Wednesday, £177 5s.

Spelter.—Messrs. Rudolf Wolff & Company, in their report, state :—Demand on the part of consumers is still poor, and the weakness of the market in the United States of America, where the price continues to fall away, has had a further depressing influence on this side. The market on the Continent has been comparatively quiet, producers there still showing little inclination to sell at to-day's level of prices, which under the present circumstances is not considered remunerative. Current quotations :—*Ordinary* : Thursday, £28 10s. ; Friday, £28 7s. 6d. ; Monday, £28 5s. ; Tuesday, £27 17s. 6d. ; Wednesday, £27 15s.

Lead.—The market for soft foreign pig continues inactive, with values again tending to lower levels. No improvement can be noted in the general position, demand remaining quiet, and covered by adequate supplies arriving. Current quotations :—*Soft foreign (prompt)* : Thursday, £24 10s. ; Friday, £24 7s. 6d. ; Monday, £23 17s. 6d. ; Tuesday, £23 15s. ; Wednesday, £23 17s. 6d.

Company News.

Horseley Bridge & Engineering Company, Limited.—Profits, £9,172; brought in, £9,075; dividend, 4 per cent. for year; carry forward, £8,247.

Thorp & Roderick, Limited, 12, Belsall Street East, Bedford.—Capital £3,000 in £1 shares. Engineers. Directors: E. C. Roderick and H. Causton.

H. W. Bull & Company, Limited, 2, Oxford Street, Birmingham.—Capital £10,000 in £1 shares (1,500 7½ per cent. cumulative preference). Engineers.

Rainwater Castings, Limited, B.O.S. Iron Works, Mottram Road, Newton Hyde, Cheshire.—Capital £5,000. Permanent directors: M. Callender, E. V. Jones and P. Oakley.

Thos. Bennett & Sons (Leeds), Limited, Harewood Street, Leeds.—Capital £5,000. Metal merchants. Directors: Thomas Bennett (governing director), F. Bennett and Thomas Bennett.

George F. Higgins & Son, Limited, Regent Engineering Works, Hay Green, Lye, near Stourbridge.—Capital £9,000 in £1 shares. Engineers, tool makers, etc. Directors: G. F. Higgins and C. F. Higgins.

A. S. Scott & Company, Limited, 89, St. James Street, Manchester.—Capital £2,500 in £1 shares. Directors: A. C. Scott, C. V. Kinna, J. K. M. Laughton, R. V. Martin and G. N. Pask. Engineers.

Platt Brothers & Company, Limited.—Net profit, £735,951; brought forward, £69,876; general reserve, £237,978; taxes reserve, £130,000; final dividend on ordinary shares, 15 per cent. (making 20 per cent.), less tax; carry forward, £66,447.

Davy Brothers, Limited. — Brought forward, £27,484; profit, £22,527; less interim dividend, January, 1923, £10,000; available balance, £40,011; final dividend on preference making 5 per cent. per annum, less tax, £1,500; final dividend on ordinary, making 5 per cent. per annum, less tax, £8,500; carried forward, £30,011.

DONALD H. SCOTT & COMPANY, LIMITED, have removed to 93, Hope Street, Glasgow.

Trade Talk.

FORTIS & PARTNERS have removed to more commodious premises at 66, Victoria Street, Westminster, S.W.1.

MR. H. M. LANE is leaving for his home—333, State Street, Detroit, Michigan—by s.s. "Paris," which sails next Saturday.

WAR MEMORIAL TABLETS were recently unveiled at the London Works and Heath Street Works, Birmingham, of Guest, Keen and Nettlefolds, Limited.

THE annual autumn meeting of the Institute of Metals will be held this year in Manchester, on September 10-13, and promises to be an exceptionally interesting gathering. The meeting will open with the second annual autumn lecture, to be delivered by Lt.-Col. Sir Henry Fowler, on "The use of Non-Ferrous Metals in Engineering."

THE FEDERATION OF ENGINEERING AND SHIPBUILDING TRADES has applied to the engineering employers for the stabilisation of wages and the consolidation of existing rates, including the 10s. which remains of the war bonus of 26s. 6d. It is also the intention of the Federation to apply at the earliest opportunity for an increase of wages by 10s. a week.

ABOUT 60 MEMBERS of Newcastle and District Association of Foremen Engineers and Draughtsmen visited the works of A. Reyrolle & Company, Limited, electrical engineers, Hebburn, recently, at the invitation of the directors, and were conducted over the various shops in which mining switch gear and electrical power switch gear for large and small power stations are being made.

DAVY BROTHERS, LIMITED, are adding an iron foundry to the Darnall Works, Sheffield. The buildings and general layout will be on the same lines as the Darnall machine shops, and it will be equipped with the most up-to-date appliances for handling all material. Arrangements have been made for the sale and manufacture of the Spearing water tube boiler, particularly in connection with its use in iron and steel works, and its application for the utilisation of furnace waste heat.

R. JENKINS & COMPANY, LIMITED, boilermakers, etc., of Rotherham, have opened offices and showrooms at 15, Victoria Street, S.W., which will be in charge of their London representative, Mr. A. Seymour Smith, assisted by Mr. C. Jenkins. The Metallic Construction Company, Bridgewater Chambers, Brown Street, Manchester, have been appointed Messrs. Jenkins' representatives in Lancashire and Cheshire. Other representatives are: Mr. R. W. Jenkins, Midlands and Potteries districts; Mr. J. Bradshaw, Wales and West of England; Mr. F. D. Sidwick, Yorkshire, Lincolnshire, Durham, Cumberland, and Eastern Counties; Mr. Norman Anton, Scotland.

AMERICAN INTEREST IN MALLEABLE CASTINGS.—The Acting British Consul at Chicago, Illinois, has notified the Department of Overseas Trade that he has been approached by an American firm of harness manufacturers, who are desirous of getting into touch with British malleable ironfounders who are in a position to offer, at competitive prices, supplies of malleable castings for use in the manufacture of harness. The firm estimate that their consumption of such castings during the coming year will reach approximately 400,000 lbs. The name and address of the inquirers can be obtained by interested firms on application to the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1.

WITH regard to the six new boilers of 325,000 lbs. normal evaporation per hour each which have been ordered by the Detroit Edison Company to be fired with "Lopulco" pulverised fuel, it is now understood that these boilers are of the "W" Stirling type of 29,000 sq. ft. heating surface, and will be installed at the new Trenton Channel Power Station. The equipment for the first section is to consist of the six boilers and two 50,000 k.w. General Electric turbines, and the working pressure is 425 lbs. gauge, with Babcock and Wilcox economisers. These boilers are intended to operate usually at about 300 per cent. American rating, that is, 300,150 lbs. evaporation per hour, but are guaranteed to take 400 per cent. rating.

Open Contracts.

East London, Cape Colony, July 11.—600 cast-iron manhole frames and covers and 2,000 step irons, for the East London Municipality.

Sedbergh, July 10-24.—Supply and delivery of about 76 tons of 5-in., 4-in., and 3-in. cast-iron spigot and socket pipes, etc., for the Sedbergh Rural District Council. Taylor & Wallin, Commercial Union Buildings, 47, Pilgrim Street, Newcastle-on-Tyne. (Fee, £5, returnable.)